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Waste Management and Research Center

Annual Report 1998

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Waste Management and Research Center

Annual Report

Fiscal Year 1998
(July 1, 1997 - June 30, 1998)

Waste Management and Research Center
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WMRC's Mission

The Waste Management and Research Center (WMRC) was formed within the Illinois Department of Energy and Natural Resources (ENR) in 1984. WMRC is charged with a mission to combine research and education; information collection, analysis and dissemination; and direct technical assistance to industry, agriculture, and communities. Working with industry to reduce waste at the source and to recycle those wastes that cannot be reduced is also a priority. In September 1989 the signing of the Toxic Pollution Prevention Act (TPPA), Public Act 86-914, which was amended in 1990 by Senate Bill 2253, expanded the Center's five programs (Research, Information Services, Industrial and Technical Assistance, Data Management and Laboratory Services) to include a Pollution Prevention Program.

The Illinois Department of Natural Resources does not discriminate based upon race, color, national origin, age, sex, religion or disability in its programs, services, activities and facilities. If you believe that you have been discriminated against or if you wish additional information, please contact the Department at (217) 785-0067 or the U.S. Department of the Interior Office of Equal Employment, Washington, D.C. 20240.

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List of Acronyms

ACES	Agriculture, Consumer and Environmental Sciences
ACTL	Alternative Cleaning Technology Laboratory
ANL	Argonne National Laboratory
CERL	Construction Engineering Research Laboratory
CMC	Chicago Manufacturing Center
CMP	Clean Manufacturing Program
DAT	Diaminotoluene
DCCA	Deparment of Commerce and Community Affairs
DFE	Design for the Environment
DM	Data Management
DMA	Department of Military Affairs
DNR	Department of Natural Resources
DNT	Dinitrotoluene
DWMA	DePue Wildlife Management Area
EAC	Environmental Assistance Center
EME	Extraordinary Monitoring & Enforcement
GIS	Geographic Information System
GLRPPR	Great Lakes Regional Pollution Prevention Roundtable
HML	Hazardous Materials Laboratory
IEPA	Illinois Environmental Protection Agency
IGIS	Illinois Geographic Information System
IMEC	Illinois Manufacturing Extension Center
ISGS	Illinois State Geological Survey
ISP	Information Services Program
ISWS	Illinois State Water Survey
IX	Ion Exchange
MOA	Memorandum of Understanding
MWRDGC	Municipal Water Reclamation District of Greater Chicago
NCOWR	North Carolina Office of Waste Reduction
NEWMOA	Northeast Waste Management Officials' Association
NIST	National Institute for Standards and Technology
NORBIC	North Business and Industrial Council
NPPR	National Pollution Prevention Roundtable
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
P2Aid	Pollution Prevention Assistance and Information Database
PAH	Polynuclear aromatic hydrocarbons
PCB	Polychloroinated biphenyl
PNEAC	Printers' National Environmental Assistance Center
RO	Reverse Osmosis
RLSP	Research and Laboratory Services Program
RPT	Responsible Property Transfer
SEPs	Supplemental Environmental Projects
SHWEC	Solid and Hazardous Waste Education Center
UF	Ultrafiltration
UI	University of Illinois
URL	Universal Resource Locator
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMRC	Waste Management and Research Center

Introduction

I would like to welcome you to the Illinois Waste Management and Research Center (WMRC) Annual Report for 1998. The WMRC saw significant change and growth during the 1998 fiscal year. This report is the chronicle of significant efforts and achievements by Center personnel.

The most significant activity of the Center was the transition of the Director's position. David Thomas, Director since its beginning in 1985, moved from WMRC to become the Chief at the Illinois Natural History Survey in November 1997. The Natural History Survey is a sister organization and is approximately three times the size of the WMRC. In the interim, Gary Miller ably, capably and effectively managed the Center as Acting Director following Dave's departure. After a search for a new director, it was my pleasure and good fortune to be appointed to this position in October 1998. I look forward to helping guide the activities of the Center and its people.

This report highlights the activities and programs of the Center from July 1997 through June 1998. During this period funding in the amount of $2,136,000 was appropriated by the state. Approximately 35 people were employed by these funds and approximately 20 more were employed working on grant and contract funds from other sources. There are many activities which are detailed in the Chapters which follow. Some of the most significant of these include:

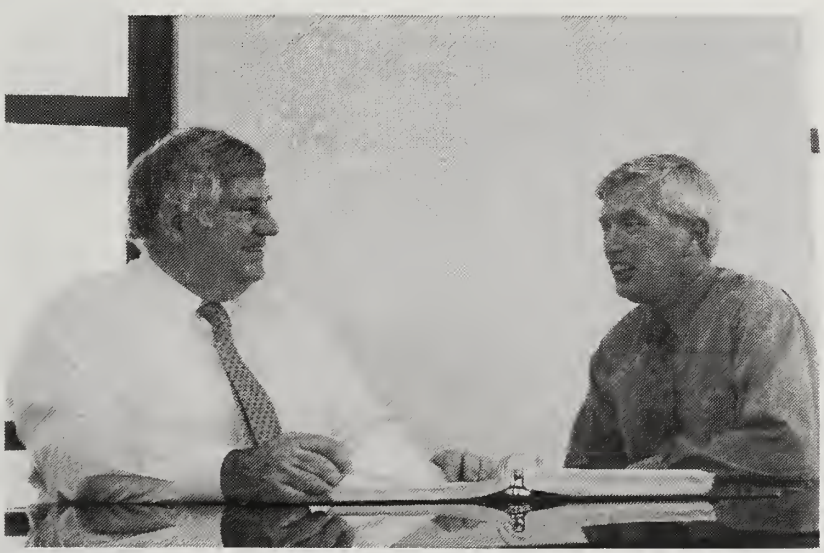
- Implementation of a new technology diffusion approach to providing pollution prevention assistance. This diffusion program will be instrumental in increasing the effectiveness of the pollution prevention program as a pilot for other programs across the nation.
- Move of the Chicago regional office into new facilities.
- Specific assistance and service by the analytical laboratories in a number of contamination issues at state owned properties.
- Management of $604,000 in scientific research funds by the Center on problems related to Illinois environmental issues.
- Providing information for a number of external groups, specifically information related to Pollution Prevention.
- Integration of data services across the Center to effectively manage the business of the Center and to provide information service to clients.

The Center continues to provide services to a wide range of Illinois clients and constituents.

Please read through the annual report and feel free to provide feedback to us on our activities as we increase our services throughout the coming years.

Sincerely,

G VanderVelde



Director George VanderVelde (left) and Assistant Director Gary Miller

Table 1. WMRC Staff List as of 6/30/98

ADMINISTRATION

George VanderVelde, Director (effective 10-1-98)
Gary Miller, Acting Director
Steve Davis, Remediation Manager (Springfield)
Katie Day, Human Resources & Admin. Services Manager
Judy Day, Receptionist/Office Assistant
Tracie Klecz, Receptionist/Office Assistant
Tenna Knox, Administrative Assistant
John Marlin, Assistant to the Director
Cindy Melchi, Human Resources/Office Assistant
Chris Murphy-Lucas, Business and Finance Manager
Cheryl Van Ness, Fiscal Assistant

RESEARCH & LABORATORY SERVICES PROGRAM

Marvin Piwoni, Lab Services Manager
Teresa Chow, Sr. Analytical Chemist
Jack Cochran, Sr. Organic/Analytical Chemist
Brad Daniels, Analytical Support Chemist
Robbi Farrell, Project Officer
Yakov Lazovsky, Glassware Washer/Lab Tech
Dan McGinness, Gas Chromotographer
Charles Chris Rohl, Facilities & Safety Coordinator
Jonathan Talbott, Sr. Analytical/Metals Chemist
Luann Wiedenmann, Inorganic Preparations Chemist
Monte Wilcoxon, Quality Assurance Specialist

DATA MANAGEMENT/COMPUTER SERVICES GROUP

Randy Wahlfeldt, Computing Services Administrator/Manager
Shane Compton, Academic Hourly
David Green, Computer Systems Specialist
George Krumins, Database Management Assistant

POLLUTION PREVENTION PROGRAM

Tim Lindsey, Pollution Prevention Program Manager
Ken Barnes, Environmental Engineer
Veera Boddu, Process Engineer
Shane Compton, Academic Hourly
Dan Kraybill, Environmental Engineer
Bill Nelson, Process Evaluation Specialist
Joe Pickowitz, Pollution Prevention Technologist
Kishore Rajagopalan, Environmental Engineer
Todd Schumacher, Project Management Assistant
Mike Springman, Environmental Specialist (Springfield)

INFORMATION SERVICES PROGRAM

Jackie Peden, Manager, Information Services Program
Laura Barnes, Librarian/Clearinghouse Specialist
Carla Blue, Events Coordinator
Sandra Broda, Information Specialist
Ester Burke, Information Specialist
Laurie Case, Communications Specialist
Chuck Cass, Hourly Student
Chris Harris, Media Specialist
Susan Herrel, Academic Hourly
Lisa Merrifield, Technical Information Specialist
Priscilla Smiley, Assistant Librarian
Gail Stamm, Undergrad Hourly

CHICAGO OFFICE

Malcolm Boyle, Sr. Engineer/Office Manager
Jerry Brown, Manufacturing Process Engineer
Chris Hayes, P2 Technologist and Process Engineer
Clifford Jahp, Environmental Engineer
Deb Kramer, Process Improvement Specialist
Caroline Pomeroy, Academic Hourly

1: Program Summaries

This chapter provides a brief overview of the Center's programs, services, priorities and facility needs.

Pollution Prevention

In 1986, WMRC's Pollution Prevention (P2) Program was established as a long-term approach to solving Illinois' waste management problems. It provides direct technical assistance to industry, education programs, and research support to promote waste reduction. For waste that can't be reduced, recycling and improved waste management strategies are encouraged.

WMRC's P2 Program encourages companies to closely examine how materials flow through their facilities, to pinpoint where and why wastes are generated, and to identify technologies, equipment, and/or new operating practices that reduce these wastes. Pollution prevention is a win-win program, wherein businesses and government cut costs and increase efficiency and competitiveness while concurrently protecting the environment.

In an effort to improve the efficiency and effectiveness offered to its customers, the P2 program reorganized in FY98. The program adopted an innovation diffusion model which had previously been sucessfully used in agricultural extension.

Pollution prevention is comprised of a cluster of innovations that can be ideas (software), materials substitution and equipment-based (hardware). P2 innovations vary greatly in their characteristics and scope. Consequently, the effort required to spread incremental P2 opportunities needing small changes in a facility is much less than the effort needed to spread a new technology requiring significant organizational change.

Most change agencies attempt to diffuse innovations by creating awareness regarding the advantages and applications for the technology. Providers of P2 technical assistance are often frustrated when their efforts to spread P2 awareness through distribution of case studies, fact sheets, or internet materials do not result in widespread adoption of P2 practices. They expect that the innovation's advantages, clearly spelled out in the information materials, will provide adequate justification for the client to adopt the practice.

Innovation diffusion researchers claim that providing this type of awareness information alone does little to facilitate adoption. They claim that implementation assistance is often required to address uncertainty associated with the compatibility and complexity of the technology. The P2 program's experience with diffusing P2 practices has been very similar. In cases where technical assistance efforts have included only providing information, adoption has been minimal. However, in cases where the P2 program has provided implementation assistance through technology demonstrations and pilot trials, the adoption rate has greatly improved.

The new P2 program organization is focused on three areas as follows: 1) performing cutting-edge research on newly developed P2 technologies, 2) creating awareness that P2 practices and technologies exist, and 3) providing implementation assistance to help organizations adopt the practices. This reorganization should improve the program's effectiveness by directing staff efforts toward activities that truly make the difference with respect to encouraging others to adopt P2. Figure 1 provides a schematic of how the WMRC P2 program now functions with respect to providing technical assistance.

Because WMRC is a nonregulatory organization, the assistance provided is advisory only; companies and individuals are not required to follow the recommendations and advice given by Center staff. WMRC does not report site-specific findings to state regulatory agencies.

WMRC continues to use its three well-equipped clean technology laboratories to solve a variety of waste management problems. Testing innovative technologies to separate contaminants from process streams is the focus of our Pilot Laboratory. Technologies such as ultrafiltration, reverse osmosis, vacuum evaporation and centrifugation are evaluated for recovery and recycling of process stream components. WMRC's Alternative Cleaning Technology Laboratory has become a recognized test facility for the demonstration of safe cleaning techniques, employing aqueous cleaners where hazardous organic solvents were previously used. Alternative Chemical Processes Laboratory staff assist synthetic and process chemists who are trying to stem pollution at the ultimate source—the process design stage. These are unique facilities within the region.

The growing demand for WMRC's services provided the incentive for a new regional office, and on December 8, 1994, the Center's Clean Manufacturing Program (CMP) was established and later this program was combined with the Pollution Prevention Program. The Chicago staff provide businesses and community groups

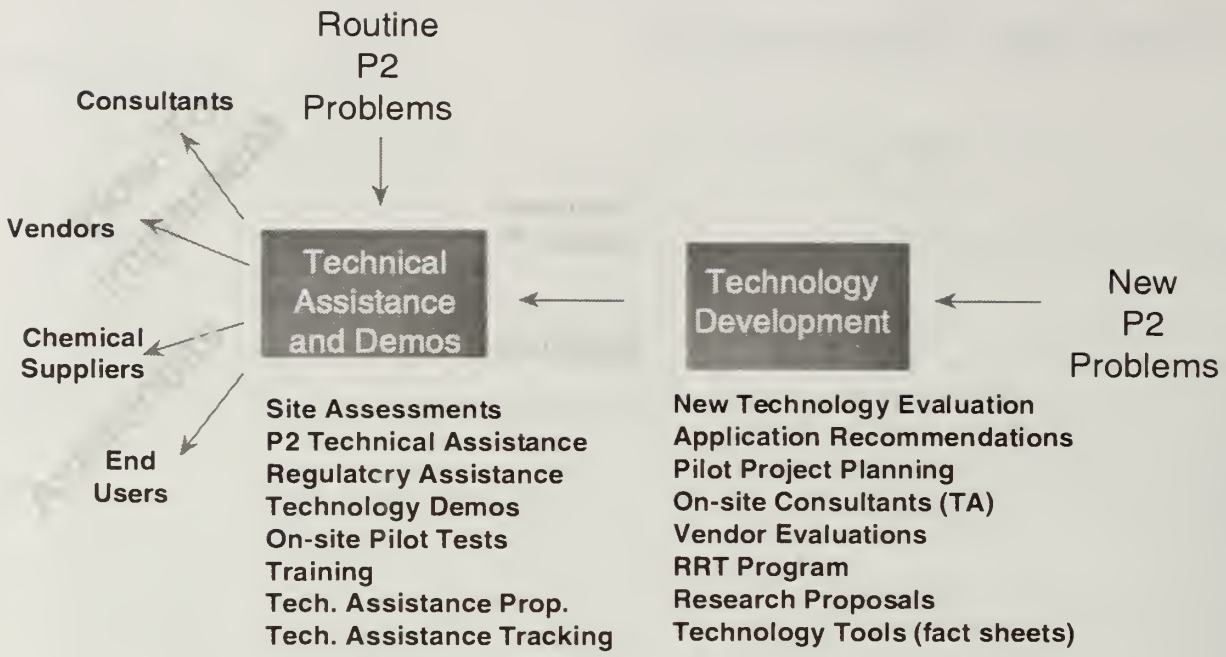


Figure 1: WMRC P2 Program Realignment

in the northern Illinois and Chicago area with technical assistance on regulatory compliance, pollution prevention assessments, safety assessments, and assistance with the implementation of pollution prevention and waste management programs. The overall response to the program has been exccellent and businesses are taking advantage of the available technical assistance to augment their environmental responsiveness.

The WMRC Chicago P2 staff work with various service providers, such as the Chicago Manufacturing Center (CMC), the North Business and Industrial Council (NORBIC), and the Municipal Water Reclamation District of Greater Chicago (MWRDGC) to integrate pollution prevention and waste management services with the business development, modernization, and competitiveness programs already provided by these organizations. As businesses consider new technologies or modify existing technologies, they will be encouraged to evaluate environmentally responsible options as part of their corporate decision-making process.

Research and Laboratory Services

Research

Since its inception, WMRC has funded and managed research on waste-related problems of concern to the State of Illinois. Research funding is provided each year through appropriations from both the General Revenue and Hazardous Waste Research Funds. These funds are used to support a variety of projects that:

- Investigate problems associated with historical and existing waste management practices;
- Explore solutions to those problems;
- Develop ways to prevent waste-related problems from occurring in the future; and,
- Explore the behavior and fate of contaminants in the environment.

In recent years a fifth category has emerged, projects that assist the Department of Natural Resource's efforts to address contamination on Department lands.

The Research staff carry responsibility for soliciting competitive proposals from the research community, coordinating an evaluation and selection process that selects the strongest proposals for funding, and then managing those projects to ensure that the work is performed and project deliverables are met. The Research staff call upon many others both within WMRC and from the greater national research community to assist in proposal review and selection. Proposals are evaluated on the following criteria:

- appropriateness to the solicitation topics and/or the interests of the State;
- innovativeness and clarity of the concept being proposed;
- suitability/adequacy of the methods and experimental design to the problem;
- qualifications of the research team; and,
- adequacy/appropriateness of the proposed budget.

For FY98, WMRC received $604,000 to support its research program. Since the funds are earmarked to address waste-related problems of interest to Illinois, most of the money is awarded to researchers in the state.

The FY98 solicitation focused on three research areas:

1) industrial pollution prevention, particularly source reduction and recycling or recovery of spent lubricants and coolants, and innovative management methods for highly corrosive waste streams (e.g. pickling baths) generated in industries such as metal fabrication, equipment manufacturing, primary and secondary metals, and printed circuit board manufacturing

2) metals contaminated sites, including a) the physical and chemical basis of innovative practices for remediating metals-contaminated soils; b) adequacy of current or proposed Illinois practices for evaluation of ecological risks; and c) defining natural processes that regulate metal availability in contaminated soils and sediments

3) issues relating to nonpoint source pollution, specifically estrogen mimics/endocrine disrupters, environmental fate of soil amendments including nutrients, and sustainable agricultural practices

Additional proposals advancing novel and technically-sound concepts were also solicited.

The majority of the research appropriation supports the basic and applied research projects received as a result of the annual solicitation. Those proposals that best respond to the most urgent problems facing the state, and that have a high likelihood of success, are selected for funding. Additional funds are made available to support technology projects with industries as part of the Center's Reduction and Recycling Technologies (RRT) program. These projects tend to be less formal and more applied, and often provide "matching" funds to a company's efforts to explore a pollution prevention approach.

Projects selected for funding during FY98 are discussed in Chapter 4 . WMRC staff work with project investigators, providing comments on the work as it progresses, serving as sources of information when needed, and often assisting with industrial process evaluations. Center staff have worked to leverage the funding allocated to the program by co-funding projects with other agencies and obtaining external funding to pursue additional topics of interest. These efforts will continue in FY98.

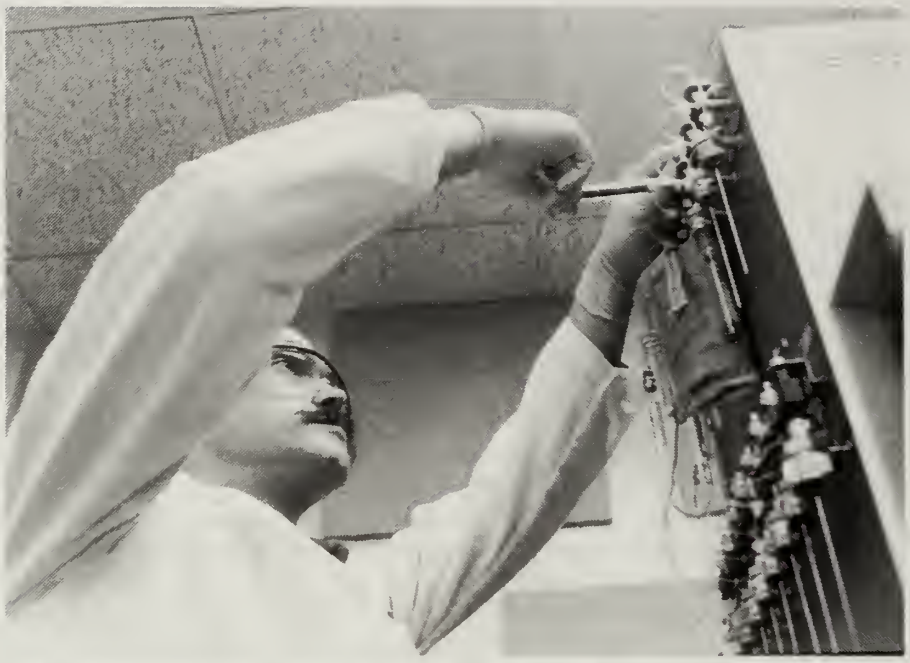
Participation in and management of Center research projects have provided opportunities for WMRC staff to become familiar with a variety of Illinois industries and the wastes they produce. Staff have also gained familiarity with the technologies and techniques that can reduce those wastes, putting them in position to provide valuable assistance to these industries. Center-sponsored projects have addressed the severity of the contamination problems in the state, how contaminated sites can be restored, how current problems can be avoided, and how both the contaminants and their elimination can impact human health.

Awareness of other hazardous waste research efforts being supported at a national level can minimize funding duplication and help identify and take advantage of joint funding opportunities. WMRC staff maintain this awareness through attending national meetings that focus on other agencies' research agendas. Such meeting participation can also facilitate the development of associations with individuals from other agencies/ organizations that fund research. Through these contacts, expert reviewers are identified for proposals and final reports. These experts are an added source of technical information essential to the selection of quality research projects. Information derived from WMRC-sponsored research is combined with what is learned from publications, technical meeting participation, and personal/professional associations to respond to inquiries from the public, legislators, industries, and others. This information also serves as a basis for technical papers and presentations, and, on occasion, policy recommendations at both the state and national levels.

The results of Center-funded and Center-conducted research are made available in a variety of ways. Articles in peer-reviewed and technical publications are encouraged, as are presentations at meetings, seminars and workshops. Fact sheets and brochures describing research project results are prepared and distributed to technical organizations and companies that might benefit from the information. The terminal deliverable from most WMRC-sponsored projects is a peer-reviewed research report, published by WMRC, and available through the Center's Clearinghouse.

Laboratory Services

The primary mission of WMRC's Laboratory Services Section is to provide analytical and logistical support to researchers working on waste-related problems. The broad range of capabilities of the Laboratory's instrumentation and professional staff allow the Center to provide analytical and technical support that address a wide variety of client interests and needs. The facility, the Hazardous Materials Laboratory (HML), was designed, constructed and equipped to support an environmental analytical chemistry group that could respond to the array of waste and contamination problems that the Center encounters.



Dan McGinnis injects a sample into a gas chromatograph for analysis.

The laboratory supports the technical assistance activities of the P2 Program by analyzing samples and providing technical guidance on sampling and analytical issues. The laboratory also assists Center-funded researchers by providing direct analytical support, access to laboratory space, and technical guidance. In addition, the laboratory provides analytical and technical support to researchers statewide (and occasionally out-of-state) who are not otherwise affiliated with the Center. Outside analytical support requests generally must meet several criteria to be honored:

- the project must have a research focus;
- the project must not involve regulatory and/or compliance issues;
- the project is consistent with the Center's mission of solving the waste-related problems of the State of Illinois.

Services are provided on a billable basis according to a services fee structure approved by the University of Illinois (UI). The University of Illinois provides billing and accounting assistance for such projects.

P2 staff often provide technical assistance to industries that include exploring the suitability of applying various engineering technologies to industrial waste problems. Laboratory support of WMRC's P2 Program usually focuses on chemical characterization of process or waste streams. For example, the laboratory has developed specialized analytical methods for oil and grease and surfactant measurements in industrial cleaning solutions as a direct result of P2 Program efforts to promote use of aqueous (non-organic solvent) cleaners and to provide technologies for prolonging the useful life of aqueous cleaning baths. Data resulting from these analyses can then be used to support decisions on appropriate engineering technologies for treating and/or reducing waste and increasing process efficiency.

Laboratory efforts in support of WMRC-funded research projects range from providing most of the analytical work required for the project to analyzing a few samples as part of a larger quality assurance program. Occasionally, laboratory staff are asked to develop analytical methodologies specific to project needs or to assist in designing experiments compatible with the analytical process. Researchers request a variety of analyses, from inorganics and metals through more complex mass spectrometric analyses to identify, measure concentrations of or confirm the existence of organic constituents.

External researchers (not WMRC-supported) bring an even broader array of analytical challenges to the Center. Laboratory staff have worked with researchers over the past year to further elucidate the mechanisms of biodegradation of diamotoluene compounds and to develop analytical methods to measure triaminotoluene, a relatively unstable breakdown product. These compounds are common products in the biodegradation of military munitions wastes and are the focus of considerable Department of Defense research. The staff also measured levels of polynuclear aromatic hydrocarbons (PAHs) in sediment from the Grand Calumet River. These compounds, some of which are suspected or identified carcinogens, are the products of combustion of fossil fuels and are often present at elevated levels in

Pollution Prevention Related Clients

Ace Plating
Brulin-Boeing
Calgon
Caterpillar Inc.
Clarin Corp.
Eagle Wings Industries
Goldsmith
Iroquois Popcorn
Lawrence Bros.
R.B. White
Springfield Inc.

State-Related Projects

Alorton Rookery
Lake DePue
Department of Military Affairs
Illinois Beach State Park

External Clients

Argonne National Laboratory
Battelle-Columbus
CERL-2 projects
ISGS-2 projects
ISWS-2 projects
UI ACES-2 projects
UI Biomedical Sciences
UI Chemistry
UI Civil Engineering
UI Nuclear Engineering-3 projects
UI Veterinary Medicine-2 projects
USGS-2 projects
Urbana-Champaign Sanitary District

Table 2. FY98 Laboratory Services Clients

urban areas. Pesticide levels in migratory bird eggs and in UI farms tile drainage water samples were measured in support of research efforts conducted at the UI. The laboratory has also undertaken analytical support of projects investigating the decline of amphibian populations in the Midwestern US and in Panama.

Several of these external projects are discussed in more detail in Chapter 4. These projects exemplify the laboratory's dedication to working with the researcher to get the information they need to successfully complete the project. The specific analytical capabilities of the laboratory are summarized in the FY93 annual report (HWRIC 1993). Table 2 summarizes the laboratory's client base during the current fiscal year.

Making laboratory space in the HML accessible to researchers from outside of WMRC is another aspect of the laboratory's research support efforts. The HML was designed to provide researchers with quality laboratory work space. Each year, WMRC supports three or four research projects by providing space within the facility. US Army Construction Engineering Research Laboratory (CERL) researchers have occupied two laboratories within the facility over the past year. These researchers, who are exploring waste problems of interest to the military, make use of the specially designed laboratories and avail themselves of analytical and other services. The Center also cooperated with the UI's Technology Innovation Center to provide space for a biochemistry-based project conducted by an independent researcher. The manager of the Research and Laboratory Services Program provides access to the facility and the analytical services at the Center.

Information Services

The focus for WMRC's Information Services Program (ISP) is resource development, collection, and distribution. The program includes eight full time and one half-time staff plus two students who work to provide information and support services to the other WMRC programs and outside clients with waste management questions. In previous years, the ISP concentrated on the collection of materials. The expansion of the program to include staff responsible for resource development, public outreach, and publicity/promotion has led to a shift in focus to evaluation of the existing resources and the mechanisms used to distribute them. This evaluation has identified several new delivery options that will be implemented during FY99.

WMRC's printed resources are contained in its library and clearinghouse. The print collections constantly change with frequent additions (496 books and tapes, 21 periodicals, and 969 articles in FY98) and periodic deletions to remove outdated and redundant material. Outdated and duplicate materials removed from the library are offered to staff or other libraries. The WMRC library currently contains over 6,000 books, government reports, tapes and maps; over 250 periodicals; and over 9,000 articles. Records for the library collection are maintained in two databases—catalog and article citations. The catalog database contains all books, reports, audio/visual materials, maps, and periodicals. The article citations database provides reference information and an abstract for articles that staff have identified as important

to their work at WMRC. The library collection does not generally circulate outside of WMRC; however, interlibrary loan requests are honored.

The clearinghouse is the repository and distribution center for administrative reports, research reports, fact sheets, brochures, pamphlets and other publications produced by WMRC staff and others. Research reports document the projects conducted by Center staff as well as those funded and administered by WMRC's Research and Laboratory Services Program. The other publications describe WMRC and its activities or provide information on 23 topical areas including household hazardous wastes, lead, and industry specific pollution prevention guidance. Clearinghouse materials are available at no or minimal costs. Some fees have been set to recover a portion of production and mailing costs for the documents. The Clearinghouse collection is also maintained in a *db/Textworks* database. The Center's print collection bibliographic database is easily accessed through WMRC's Local Area Network from staff office computers and work stations in the library.

The Center has become increasingly involved in regional and national efforts to network assistance providers and/or clearinghouses. ISP staff are working on a number of federal grants to develop information resources and distribute them in both print and electronic formats. These projects include information collection and evaluation, database development, web page development, list server maintenance, and electronic delivery system evaluation. These projects are discussed in Chapter 5.

ISP staff write, review, edit, and format proposals, reports, fact sheets, and other documents produced by WMRC and the researchers they fund. The program is responsible for the production of presentation and promotional materials including slides, overheads, posters, brochures, and press releases. ISP maintains a mailing list database that includes standard location information as well as specific data on materials requested and the individual's participation in Center committees or advisory bodies. This database allows the targeting of the best audience for announcements about WMRC materials and activities. The primary mechanisms for

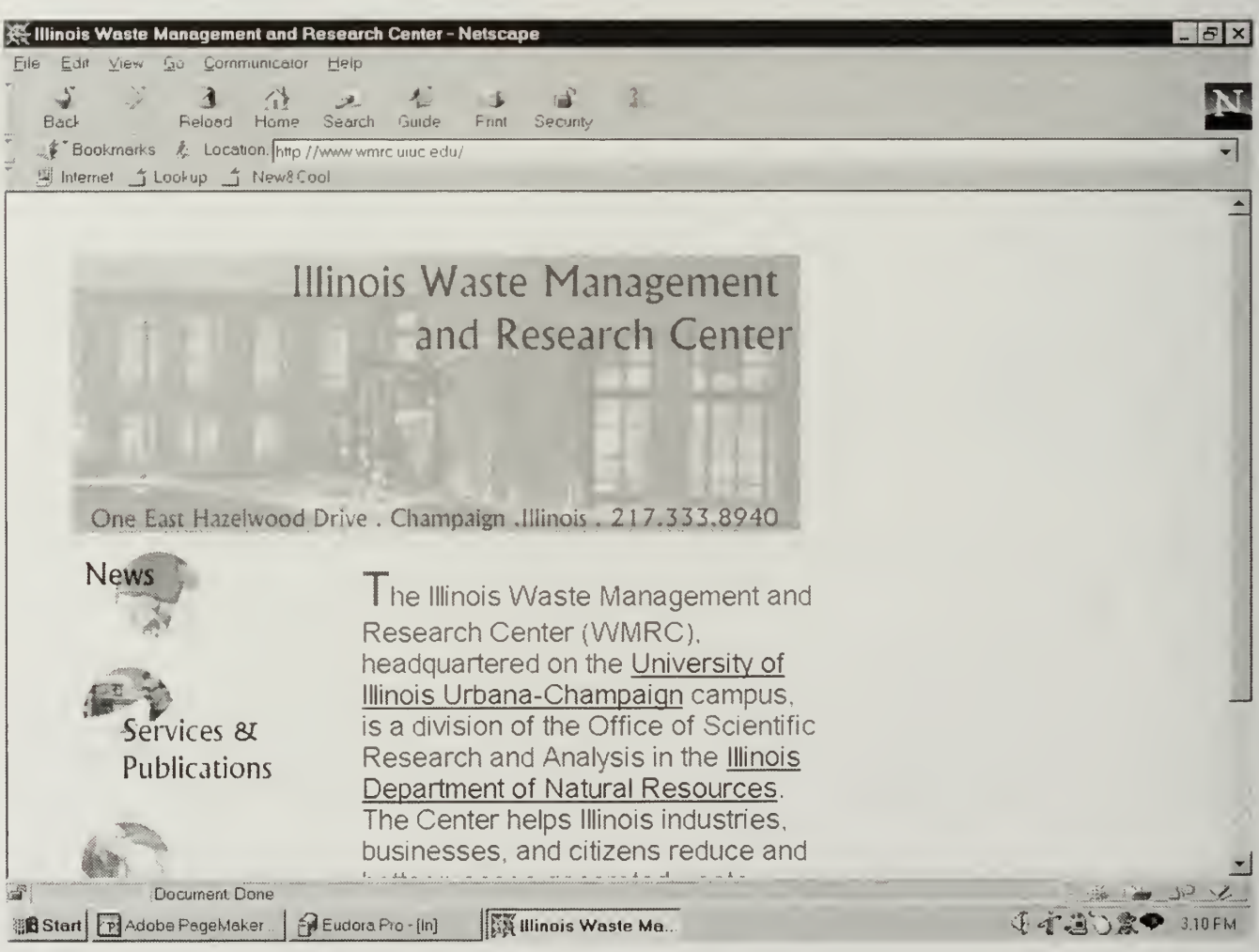


Figure 2: The updated WMRC World Wide Web Homepage

WMRC's Library provides a wide selection of materials specific to waste management issues.

publicizing WMRC's activities are meeting/conference presentations, press releases, and the Center's newsletter, *Illinois Update*. The newsletter is published several times a year to update interested individuals on the latest Center activities, projects, workshops, and resources.

Meeting coordination has become an increasingly important function for the ISP. This is due to the increased number of workshops and training sessions conducted by WMRC staff. ISP staff also coordinate the two annual meetings of the Great Lakes Regional Pollution Prevention Roundtable (see Chapter 5) which requires not only arranging for speakers but also all of the meeting logistics such as facilities, audio visuals, and refreshments. ISP staff also frequently assist with the meeting arrangements for groups using our conference room and serve as the coordinators for the annual Governor's Pollution Prevention Award ceremony.

Recently, ISP staff have accepted the responsibility for upgrading and maintaining WMRC's home page. (The updated WMRC Web pages can be accessed at http://www.wmrc.uiuc.edu). The home page team has reviewed and redesigned the page, and developed templates for each of the Center's core activities. Existing information was reformatted and upgraded, and a web page maintenance protocol put in place. ISP staff work with staff from each of WMRC's programs to assemble essential information about each group and select activities and/or projects that should be highlighted. Page maintenance will include additions of new topics, updating of existing materials, and removal of outdated information.

Data Management Group

The Data Management (DM) Group supports the Center's mandate directly and indirectly. Since computers have become an integral part of the office and laboratory, the Center would stop efficiently functioning without the internal support of DM. At the same time, computers are used to distribute waste-related information through the use of Geographic Information Systems (GIS) and the World Wide Web. Diverse computer hardware and software are maintained and upgraded on a continual basis, not only for the individual user, but also for the analytical instrumentation used in WMRC's Hazardous Materials Laboratory.

Two of the most visible aspects of the DM group are the Center's GIS programs and World Wide Web pages. Information on the locations, quantities, properties, and components of hazardous material and waste management facilities are extracted from the GIS and other databases. This information can be used for a variety of purposes including responsible property transfers (RPTs). RPT information is provided to individuals, companies, and state agencies, including DNR, in a form such as maps, tables, and electronic files. The data used comes from sources including USEPA, IEPA and research conducted or sponsored by the Center. WMRC is also part of the Illinois Geographic Information System (IGIS), which develops and maintains Illinois geospatial datasets. WMRC GIS also continues to support Conservation 2000 through the Critical Trends Assessment Program.

The continuing explosion of the World Wide Web provides benefits and responsibilities for the DM group. Although the Information Services Program maintains the content and design of the Center's web pages, DM provides support with software and hardware. DM staff also represent the Center on the DNR Web Team. This team serves as the conduit for information regarding Year 2000 (Y2K) issues, as well as other computer-related issues within DNR.

Facilities Development

The Center's continued growth has increased the services that can be provided and the size of our client base. In recent years much of this growth has been the result of WMRC winning an increasing number of contracts to provide regional and national support to P2 and information resource efforts. At the same time, WMRC management has sought additional state support for critical programs such as P2 and the Department's new natural resource damage assessment/remediation

efforts. The result is that the Center is running out of office and support space. To address this problem, we have proposed an 8,000 to 9,000 square foot addition to the current building. This addition would provide additional library/clearinghouse and conference space, more storage and filing space and about 20 additional offices. The Capital Development Board is currently doing a cost evaluation on this proposed addition.

Also, during the past year the Center's office in the Chicago area was moved to Oakbrook which is a better location for serving business clients in the entire metropolitan area. Office space was also obtained for two staff that are located in Springfield. As those efforts grow in the future, additional office space will be needed.

2: Pollution Prevention Program

Introduction

This fiscal year has seen the Pollution Prevention Program undergo an internal redefinition of priorities, as presented in Chapter 2. With this methodology, the program anticipates a more focused and ultimately more efficient response to the pollution prevention needs of Illinois businesses. This chapter provides examples of the building blocks upon which the WMRC P2 staff will base their future efforts—innovative technology development, outreach/partnerships, and technical assistance to Illinois companies.

Technology Laboratories

Alternative Cleaning Technology Laboratory (ACTL)

The need for Illinois companies to reduce volatile emissions have continued to push them toward alternative parts cleaning technologies. The ACTL has worked predominantly with companies who need assistance with degreasing applications from metals. Included in this area would also be tests performed for companies on cleaners they are marketing.

The ACTL has also received requests for assistance in alternative cleaning technologies in applications quite distinct from degreasing. The newer areas involve chemical process tank cleaning focusing on cured and uncured resins. The removal of dried paint and experiment/process residues provide further challenges for the ACTL.

The work within the laboratory has led to differentiating the appropriate uses of mechanical modes of cleaning. Results from two companies the ACTL staff have worked with indicate that ultrasonic cleaning tanks and spray washing systems have their respective strengths and weaknesses. This area of work will be of increasing importance in the future.

The ACTL staff have expanded their efforts to communicate the knowledge gained through presentations at various professional meetings as well as papers published in the trade press.

Educational Outreach

Steve Skerlos and Dr. Tim Lindsey developed and taught a course called, "Environmentally Conscious Manufacturing and Pollution Prevention," at the University of Illinois at Urbana-Champaign in the spring semester of 1998. The concept for the course was derived from the need for engineering and science graduates to understand the cause and effect relationship between design and manufacturing decisions and environmental degradation. The course mission was to provide the conceptual, methodological and technical tools for asessing the benefits of incorporating pollution prevention into decision-making.

The course had the following six objectives: 1) cover the basic principles of pollution management and relate them to system design; 2) review impacts of environmental legislation on manufacturing; 3) introduce pollution prevention concepts and methods; 4) develop the technical tools to support environmentally conscious manufacturing; 5) raise awareness about available concepts and programs to facilitate environmentally conscious manufacturing and P2; and, 6) provide specific examples and case studies to show how these tools and

Steve Skerlos delivers a lecture on pollution prevention.

concepts have been applied to actual product and process design.

While the bulk of the instruction was provided by Mr. Skerlos and Dr. Lindsey, several special guest lecturers discussed such diverse topics as environmental legislation, environmental systems analysis, and design for the environment (DFE). One of the key elements to the success of this course, in the eyes of the students, was its balance between philosophical issues and technical issues. The main philosophical impetus for the course established the links between profitability, traditional quality considerations (e.g., as taught by W. Edward Deming), and environmental quality and improvement. Technical tools provided for the students included basic environmental science, environmental modeling, statistics, and decision-making.

The course offered several opportunities to apply the concepts discussed in class, and according to the students themselves, this enriched their learning experience. Besides offering a large collection of technical and non-technical readings, the instructors provided a wealth of homework problems to simulate the real environmental problems that they have witnessed first-hand in their work. Throughout the semester, the students worked in groups to realize real-world pollution prevention opportunities in several Central Illinois manufacturing facilities. The projects included: assessment of parts cleaning and powder coating; use of membrane filtration for recycling of cleaning solutions; assessment of wood waste manufacturing practices; and, assessment of a paint process line.

After completing the course successfully, the extraordinary efforts and interest in the environmentally conscious manufacturing/P2 field by the students was acknowledged in the development and awarding of the first DNR-endorsed Pollution Prevention Industrial Training certificates issued by WMRC.

Partnerships

Reducing Mercury Releases Through P2 in Health Care Facilities

This project is a partnership between IEPA and WMRC. This partnership, with the cooperation of hospitals and health care facilities, is an effort to promote pollution prevention in these facilites in the Chicago metropolitan area, with a particular emphasis on mercury-containing products and waste streams. Twenty healthcare facilities are to have P2 assessments performed by WMRC and IEPA over the life of the two-year project.

The primary objectives of this project are to: first, provide training to local and state agencies' environmental personnel on strategies for alternatives to the use of mercury in the health care profession and, second, increase pollution prevention awareness in the health care facilities and encourage the development of pollution prevention plans.

The effort to contact and provide outreach services to Chicago area hospitals is in progress. The University of Illinois at Chicago, Central DuPage Hospital, Cook County Hospital System, and Catholic Health Partners have made firm commitments to establish P2 programs with assistance from WMRC and IEPA.

Other activities undertaken this fiscal year include: 1) consultants were hired to conduct a "P2 in Healthcare Facilities" workshop on February 24, 1998 to train WMRC and IEPA personnel on pollution prevention opportunities common in healthcare facilities; 2) P2 assessments of two hospitals were conducted on March 31 and April 1, 1998 as part of the P2 training for WMRC and IEPA personnel. This training will help Center staff in identifying problem areas which contribute to the mercury releases to the environment from healthcare facilities; and, 3) a certification program is being develop by WMRC and IEPA for "Mercury-Free Environmental Partners."

WMRC and the Department of Military Affairs Enter Into a Partnership

This year, WMRC entered into a partnership with the Illinois Department of Military Affairs (National Guard) to share information concerning pollution prevention opportunities. Michael Springman from the Center has been working directly with the DMA to assist them in managing their pollution prevention projects.

This past year the partnership focused on investigating vehicle wash rack recycling opportunities; used vehicle fluid filter recycling; alternative site remediation techniques; and parts washer water and detergent reclamation using ultrafiltration techniques. WMRC also assited DMA by managing their underground storage tank removal and indoor rifle range remediation projects.

This partnership will continue for one more year with emphasis being placed on pollution prevention assessments of DMA facilities; the development of an automated weapons cleaning system incorporating pollution prevention technologies; outdoor range remediation and reclamation; and, the development of a system to recover turbine engine jet part cleaning chemicals.

Partnering With the Chicago Manufacturing Center (CMC)

WMRC has an ongoing partnership with Chicago Manufacturing Center through a National Institute for Standards and Technology (NIST) grant, which was

initially received in 1995. WMRC assists CMC in evaluating environmental concerns of businesses requesting assistance, and strives to integrate pollutin prevention considerations into business modernization projects. This association has been extended until the end of December 1998. As a non-regulatory environmental assistance agency, WMRC, through CMC, has helped companies with compliance issues, pollution prevention, waste and safety issues.

In FY98 WMRC joined CMC on 12 company assessments, 23 informal technical assistance projects, and provided on-the-job training to employees of five different companies. In addition, together this partnership developed 27 projects with companies in Chicago and the collar counties. These projects assisted companies in substitution of alternative cleaners for chlorinated solvents, reduction of pollution in plating companies, elimination of vapor degreasers, as well as other pollution prevention areas.

North Business and Industrial Council (NORBIC)

A collaborative effort between WMRC and NORBIC was formed for outreach to businesses in the NORBIC service area. NORBIC is a highly successful economic development organization assisting in the retention, expansion, and development of business and industry, primarily on Chicago's north side. NORBIC serves over 1,700 manufacturing companies, representing over 300,000 jobs in the Chicago area. Businesses in the area have come to trust NORBIC's services.

The partnership between NORBIC and WMRC focuses on providing environmental compliance and pollution prevention assistance to businesses in the NORBIC area. WMRC staff answer questions about environmental regulations, compliance issues, safety concerns, and implementation of pollution prevention technologies and programs. Technical assistance is being provided by accompanying NORBIC's staff to facilities, by the establishment of a satellite pollution prevention clearinghouse at the NORBIC office, and by working with NORBIC's Environmental Assistance Center (EAC). The EAC is partially funded by WMRC to provide direct technical assistance to businesses. This partnership has proven to be an effective way for WMRC to work with a trusted and credible business organization to reach their members.

Argonne National Laboratory (ANL)

A partnership has been established between WMRC and Argonne National Laboratory (ANL) to work on a project funded through the DuPage County Solid Waste Department. WMRC and ANL will be providing technical assistance to high school chemistry teachers in the use of microscale chemistry. ANL will teach the fundamentals behind microscale chemistry and WMRC will conduct pollution prevention and chemical management assessments of the high school chemical storage areas. Ten high schools in DuPage County are to be part of this project. This project is scheduled to begin in FY99 for a one year period.

Partnership Develops with Illinois Manufacturing Extension Center (IMEC)

The IMEC organization held its quarterly meeting at WMRC on June 24 - 25, 1998 for approximately 50 of its project managers and technical specialists. Quarterly staff meetings provide IMEC staff with information pertaining to job performance, client review, project management, and other administrative and technical subjects. In addition to this training, Tim Lindsey, manager of the WMRC Pollution Prevention Program, presented a seminar on "The Diffusion of Innovation." Following Mr. Lindsey's presentation IMEC staff participated in a tour of the Center's laboratories, pilot equipment, and library.

On the second day of training, members of CMC and the Illinois Department of Commerce and Community Affairs (DCCA) joined the meeting and provided presentations on methods of client interaction and financial assistance available through DCCA's loan and grant programs. WMRC has formed an important partnership with IMEC to provide environmental assistance to the IMEC organization and its manufacturing clients. Through IMEC project manager's numerous field contacts, WMRC may gain access to companies who might normally be suspicious of government technical assistance providers.

Printer's National Environmental Assistance Center (PNEAC)

WMRC receives funding from USEPA to serve as a partner in the Printer's National Environmental Assistance Center. EPA's Office of Compliance and Pollution Prevention Policy has partnered with industry and state environmental experts to create an environmental assistance center for the printing industry that comprehensively addresses the environmental compliance needs of small printers, plus provides information on how to achieve compliance by reducing waste and emissions. The intent of PNEAC is to work in collaboration with printing trade associations and other printing industry experts, regulators and technical assistance providers to develop and deliver environmental and technical resources for printers.

PNEAC is a multi-accessible telecommunications-based center that can be reached via a toll-free number, e-mail, fax and web site that electronically link trade,

governmental and university assistance providers to provide the most current and complete compliance and pollution prevention information to the printing industry.

Products and Services

The PNEAC World Wide Web home page (www.pneac.org) is regularly updated by WMRC staff and expanded with current industry technical developments and compliance issues affecting the industry. The site also includes summaries of federal and state regulatory initiatives and requirements for printers, compliance policies and guidelines, pollution prevention case studies, sources of additional information and expertise, schedules of conferences and training events, answers to common questions, and a place to post questions to industry compliance and pollution prevention experts. On average, 7-10 requests and inquiries are posted from the web site each month. The web site also contains information on Illinois programs such as the Great Printers Project which includes a current list of all the Illinois Great Printer companies.

Seven new fact sheets on compliance issues affecting commercial printers were developed and three have been updated over the last year.

On December 2, 1997, the second annual national video conference was broadcast throughout the U.S. and Canada. In Illinois the videoconference was viewed from five different locations. This video conference focused on environmental compliance and waste reduction opportunities in the lithographic printing industry.

A third annual national video conference is being developed and will be down-linked at four sites in Illinois on December 2, 1998. The video conference will focus on environmental compliance and waste reduction opportunities in the screen printing industry. WMRC and DCCA will host down-link sites in Chicago, DesPlaines, Collinsville, and Springfield.

PRINTECH and PRINTREG are listservs provide electronic links to technical information and expertise on pollution prevention technologies and regulatory issues of concern to printers and government agencies. Over 350 individuals from federal, state, and local government agencies participate; as well as representatives from industry trade associations, vendors, and printers themselves. On average, 57 questions and inquiries for additional information are posted to the listservs each month.

Training was provided to 80 individuals from EPA Region 2 Offices, New York state environmental regulatory agency, Region 4 technical assistance provider agencies, New York City environmental regulatory division and citizen action groups. The training program explained the four primary printing processes, related regulatory issues and pollution prevention strategies. A second training program is currently under development for EPA Region 4 representatives.

Great Printers Project

Illinois now has 22 designated Illinois Great Printers and approximately 75 Great Printers in Progress. This collaborative effort of WMRC, IEPA, DCCA, Printing Industries of Illinois and Indiana and the Center for Neighborhood Technology continues to develop and distribute a variety of information materials specific to the environmental concerns of printers.

Greater Chicago Pollution Prevention Program

Over the past six years, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), IEPA, City of Chicago, US EPA and WMRC have joined efforts to promote multi-media pollution prevention in the Chicago area among industry, government and community groups. There are not many, if any, other examples in the US of cooperative projects such as this. The unusual aspect of this project is that federal, state, and local governments are voluntarily working together to promote pollution prevention in a large, heavily industrialized geographic area. Community groups and economic development councils have also been participating in the project.

During previous years, seven tasks were undertaken. The project focused on pollution prevention training for agency inspectors, technical asistance, and education programs for industry, community groups and businesses such as workshops and training seminars. A technical assistant was hired by WMRC and located in the MWRDGC offices. This opened a means to effectively help companies implement pollution prevention technologies and achieve compliance with a wide range of environmental regulations.

Throughout this fiscal year, the primary activities undertaken include outreach efforts, responsing to inquiries, and providing technical assistance to busineses through on-site vistis and follow-up reports. Attending bimonthly meetings integrated efforts through the various participating organizations, tracked progress and developed new efforts to encourage pollution prevention in the Chicago area.

More than 50 companies, organizations, or individuals have been helped this year through site visits, phone assistance and written correspondence or distribution of information materials. This includes 33 site visits and assessments at 25 companies of which 18 companies had not previousdly worked with the Center.

11th Annual Governor's Pollution Prevention Award Winners

Award Winners

Large Industry Category
- Caterpillar Inc.—Decatur
- Caterpillar Inc.—East Peoria
- Commonwealth Edison
- United States Postal Service—Peoria

Medium Industry Category
- Eagle Wings Industries, Inc.
- The Gates Rubber Company
- Stepan Company

Small Industry Category
- McWhorter Technologies, Inc.
- Panek Precision

Continuous Improvement Category
- John Deere Harvester
- Highland Supply Corporation
- Motorola Land Mobile Products Sector

Vendor Category
- Navistar International

Certificate Winners

Large Industry Category
- Chrysler Corporation

Medium Industry Category
- American NTN Bearing Manufacturing Corp.

Continuous Improvement Category
- Abbott Laboratories
- Argonne National Laboratory
- Baxter Healthcare Corporation
- Dopaco, Inc.
- Olin Corporation
- United States Postal Service—Carol Stream

Table 3. 11th Annual Governor's Pollution Prevention Award Winners

CleanTech'98 International Cleaning Technology Exposition

WMRC's Pollution Prevention Program participated as an exhibitor at the two-day exposition held May 20-21, 1998 at the Rosemont Convention Center. A total of 300 exhibitors showcased the newest cleaning options available to manufacturers. WMRC played a major role at the exposition demonstrating the ability of membrane filtration to effectively separate soils from aqueous cleaning solutions. WMRC set up two demonstrations for cleaning firearms caked with oil. In the first demonstration two 55-gallon tanks, one for cleaning and the other for rinsing, were used to clean the parts by soaking them in an aqueous cleaner. The second demonstration used an ultrasonic unit to clean the parts that were immersed in an aqueous cleaner. While the parts were being cleaned the aqueous solution of each demonstration was filtered and returned to the demonstration baths. During the two days, WMRC engineers and scientists greeted exposition attendees, verified the effectiveness of the WMRC demonstrations and provided information on WMRC's services and various pollution prevention technologies. A total of 40 follow-up leads were collected.

DNR Director Brent Manning presents a 1997 Governor's Pollution Prevention Award to Edward Anesi of Motorola Inc.

11th Annual Governor's Pollution Prevention Awards

On October 29th, DNR Director Brent Manning presented the 11th Annual Governor's Pollution Prevention Awards to 21 Illinois businesses (see Table 3). These groups demonstrated their commitment to pollution prevention and have achieved outstanding results in their programs to reduce waste at the source as outlined in their applications. Awards were presented during a luncheon ceremony at the Hotel Pere Marquette in

Peoria. A booklet providing brief descriptions of the the award winners pollution prevention activties can be obtained from the WMRC Clearinghouse. Pollution prevention staff conduct reviews of the applications and visit the sites of the finalists.

WMRC Assists Company with ISO 14001 Registration

A WMRC engineer assited a northwestern Illinois automotive air/fluid systems manufacturer to register their environmental management system with the International Organization of Standardization's ISO 14001 standard. A main component of the ISO requirements was training. WMRC provided two training seminars to the company—a management overview and an employee's awareness seminar on the requirements of the international standard. As part of the company's cross-functional team, WMRC provided assistance in industrial process mapping, environmental aspects and impact identification, the development of environmental objectives and targets, and pre- and post-registration auditing assistance. WMRC is also providing ISO 14001 assistance to a sister plant in the Chicago area.

Case Studies

East Peoria Company Seeks Help with Acid Emissions Cloud

WMRC engineers provided pollution prevention technical assistance to an aluminum wire coating company in East Peoria, IL. The company was seeking an air permit from IEPA to emit 86 tons of hydrochloric acid (HCl) fumes into the environment. The company had been identified as one of 760 major emission sources in Illinois requiring a Clean Air Act Title 5 permit.

The company president contacted WMRC through the Illinois Manufacturing Extension Center (IMEC) to review the facility and provide pollution prevention options. The company uses HCl to prepare the wire to receive an aluminum coating. Several end-of-pipe options were available to reduce the HCl emissions such as a mist eliminator or a wet air scrubber. However, by tracking the problem to its root cause WMRC was able to suggest a process change that would eliminate one of the causes of the HCl emissions—a 1,600 degree natural gas oven used to remove oil and grease from the wires in-process prior to HCl pickling. The company's present process quenches the superheated wires in the HCl bath causing a vapor cloud to form and be emitted to the atmosphere. A WMRC project to eliminate the natural gas oven and install an aqueous cleaner bath to remove the oil and grease prior to the HCl pickling process is anticipated to decrease the company's HCl emissions and save an estimated $60,000 in natural gas costs each year. The installation of a mist eliminator in the exhaust stack above the HCl pickling bath will further decrease HCl emissions by approximately 75%. A future project will look at substituting the HCl process with an aqueous solution that will clean and prepare the wire for aluminum coating.

Assistance Provided to an Aluminum Die Casting Manufacturer

WMRC assisted a major manufacturer of aluminum die castings in developing and implementing a pollution prevention program. The company had been disposing of 127,000 gallons of used water and glycol per year ($21,000 annually). WMRC and the company identified an opportunity to reduce the disposal costs for this mixture by purchasing an evaporator that reduced the amount of water being disposed of off-site. Annual operating expenses are approximately $7,000 per year, yielding a 2.5 year payback period.

This company also looked into the purchase of shot control units for use in the casting machines. Shot control units are designed to allow only the required amount of liquid aluminum into the casting die for the specific size of the casting. This reduces the amount of scrap/recycled aluminum that is produced during the casting process. The company purchased four of the shot control units which reduced the amount of aluminum material that was recycled internally or taken off-site for recycling.

WMRC and the company also set up a procedure to identify three different types of aluminum ingots used in their process. In the past, some of the aluminum ingots were used to produce product that had a different specified quality ingot. With the use of the color coded identification system, the company now has eliminated the use of non-specified ingots, and reduced the amount of aluminum castings that were scrapped or recycled. The company has also been successful in recycling aluminum flash and scrap on-site. Aluminum turnings, particles, dross, and chips are sent off-site for recycling.

The company has looked at a number of ways to reduce, eliminate or contain product that is used in their manufacturing processes. The above examples show that pollution prevention can be instituted in almost any production activity, from raw material acquisition, product manufacturing, to material storage.

Pollution Prevention Through Product Quality Control

A tack cloth manufacturer was exploring possibilities of process improvements by reducing the use of off-specification raw materials. The company approached WMRC through the Chicago Manufacturing Center for

help with setting up quality control test procedures and to help with their pollution prevention efforts. The company did not have established quality standards for raw materials or for the product. Maintaining the quality of product through standardized tests and comparing with benchmark tack cloth were suggested to reduce their waste generation. Important information on developing benchmark tack cloth test procedures was provided to the client. Test procedures for measuring properties of raw materials (viscosity, moisture, and acid number) and the product tack cloth (tackiness and color) were described. Data from the test methods were used for defining acceptable and off-specification products and to setup criteria for selecting raw materials. Along with the test procedures, preliminary data were collected on the sample materials provided by the industry. Pollution prevention is achieved by reducing the production of off-specification tack cloth via verifying quality of raw materials, and polymer blends used in the manufacturing process.

WMRC Helps Metal Hardware Manufacturer

A metal hardware manufacturer was issued a consent order from the USEPA for past effluent violations of the Clean Water Act. Production operations at the facility include metal fabrication, electroplating, finishing and assembly. The facility also operates a wastewater treatment facility which had already been upgraded since the occurrence of the effluent violations. Therefore, the company decided to propose several Supplemental Environmental Projects (SEPs) focusing on pollution prevention as part of the consent decree. WMRC was contacted to conduct a detailed pollution prevention assessment to identify potential projects that could be used as SEPs. A team of employees worked with WMRC to develop a process map of the operations depicting the inputs (raw materials) and outputs (wastes). Six main projects were identified during the two-day assessment.

Three of the identified projects were proposed and accepted by USEPA as SEPs, reducing the penalty by approximately $30,000. A pilot study for recycling and reclaiming an electroplating cleaner using membrane filtration was conducted and a full scale system has been implemented. It is estimated the company will reduce hazardous waste by 9,800 gallons per year and save $22,500 per year in raw material and disposal costs through implemenation of this project. In addition, plant personnel researched and implemented projects to eliminate hexavalent chrome plating and reduce water use through employee education, engineering controls and reuse. The benefit of the SEPs to the company was that rather than pay the full penalty, the company was able to use some of that money to invest in pollution prevention projects that will benefit the environment and result in a cost savings.

Ace Plating Company Wins with Long-Term Technical Assitance from WMRC

Ace Plating Company is a small Chicago job shop offering a variety of decorative electroplating finishes including various types of brass, nickel, bronze and copper. In 1995, with WMRC's assistance, the management at Ace launched an aggressive effort to use environmentally responsible processes and procedures in all of its business operations. WMRC staff members examined the company's processes and made specific recommendations to enhance pollution prevention. These included: increasing drainage time in order to reduce drag-out, re-using the dead rinse tank contents as make-up water, repairing all leaky valves, limiting rinse water flow rates, and recycling the rinse waters.

Previous water usage of 20,000 gallons per day average was reduced to 2,500 gallons per day average. Total metals discharged annually were reduced from 176 pounds (1993 base year) to 116 pounds annually at the end of 1995. This 34% reduction in metals discharged to the environment was only expected to yield a 25% reduction in the local POTW's extraordinary monitoring and enforcement (EME) surcharge. Still facing a $12,000 annual added expense for discharging metals, the owner of Ace Plating chose to pursue zero process water discharge as a means of completely eliminating the charge. Ace continued with the source reduction practices, but increased the water flow to allow an added degree of quality assurance.

Different technologies were examined to determine their economic and practical feasibility for achieving zero discharge at the Ace Plating facility. A pilot lab reverse osmosis (RO) unit was used to test rinse water from Ace Plating's process. The unit produced a quality product water stream at about 80-85% recovery. The remaining 15-20% waste stream contained the rejected metals. This material would have to be evaporated or a second RO unit would be required to further separate the materials. The budgetary cost for a single RO unit was $45,000 and a simple evaporator to process the remaining one gallon per minute was priced at $20,000. Total operating costs were estimated at about $11,000 annually. Noting the payback time and considering the additional labor to operate the equipment, RO was eliminated as a closed-loop option for Ace Plating.

Different ion exchange (IX) vendors sampled Ace's rinse water and made recommendations for systems to recycle the water. Most admitted that organics and other dissolved solids would build up in the system. Additional technology could be combined with the IX system, but with IX alone costing between $40,000 and $65,000 (annual operating expense about $12,000), it was decided to bypass the IX option.

Evaporation was also considered. Capital cost was quoted between $45,000 and $55,000 with annual operating expenses estimated at about $6,000 to $8,000. It was believed that Ace's process could operate successfully using only two gallons per minute fresh water (to keep evaporation costs low). Economically, Ace could save about $6,000 per year if this was successful. The extended payback period and the fact that evaporation simply disposed of the water (no beneficial re-use) made it difficult to embrace evaporation as the best solution.

In mid-1996, the concept of electrocoagulation was reviewed by the WMRC project team. Electrocoagulation was touted to remove metals, suspended solids, BOD, COD and some inorganic salts and dissolved solids while producing less sludge than that produced with chemical precipitation. For a 5-gpm unit, the initial capital and annual operating costs were estimated to be $10,000 and $1,000, respectively.

Following preliminary lab and pilot lab testing, WMRC did extensive on-site testing of the first manufacturer's electrocoagulation unit. After concluding that the unit did not perform as stipulated, a second manufacturer's unit was tested. This second manufacturer's unit had won the Governor's P2 award in North Carolina and the company had several units in operation. Due to time constraints, on-site pilot testing was limited and the unit was ordered. About 15 months after first learning about electrocoagulation, the unit became operational at Ace Plating.

Table 4 shows how the water and sewer usage and costs have changed at Ace Plating over the past six years. Water usage has decreased by 88%. Water and sewer user charges have corresponsingly decreased in a similar manner. If Ace Plating's appeal to have the 1998 metal loading cost reduced is successful, it is expected (based on current precedence) that the final charge will be at least 80% lower than the initial fee assessed in 1995.

Since October 1997, Ace Plating has been closed loop, except for occasional batch discharges to lower the salt content of its rinse water. Based on water bills since then, the water usage for 1998 has been calculated to be about 60,000 gallons. Ace discharges 1,000 gallons of process water per week (52,000 gallons annually). Approximately 100,000 gallon is lost annually due evaporation at the process tanks. The remaining 430,000 gallons are used primarily for sanitary purposes with a minor amount being discharged as boiler blowdown. The water is able to meet all discharge regulations. Based on an average total metal content of 2.0 ppm, total metals discharged in 1998 should be less than one pound. The overall system uses standard water treatment technology that operates as expected. The electrocoagulation unit has not performed as expected and this technology is still being evaluated.

YEAR	Water Flow (gallons/year)	Water and Sewer Cost ($/year)	Total Metals (pounds/year)	Metals Loading Cost ($/year)*	Total Water and Sewer Cost ($/year)
1993	4,929,320	9,739	176.4	Not assessed	9,739
1994	5,378,120	10,239	118.7	Not assessed	10,239
1995	3,635,280	6.727	116.1	16,763	23,490
1996	1,817,640	3,414	101.5	13,709	17,123
1997	1,623,160	3,117	19.2	12,347	15,464
1998**	578,950	1,123	1	12,474	13,597

*Metals loading cost is assessed by the local POTW for metals discharged two years in arrears. For example, the 1995 metals loading fee is based on the pounds of metal discharged in 1993. The cost is also dependent upon the number of metal finishers assessed and the overall cost for monitoring the discharge of the metal finishers.

**1998 figures have been estimated based on existing 1998 data. The 1998 metal loading charge (based on 1996 data) was appealed due to the fact that Ace Plating is now a batch discharger. Continuous monitoring by the local POTW is no longer necessary or possible.

Table 4. Ace Plating—Water Flow, Metals Discharge and Cost Data

3: Research and Laboratory Services

Introduction

The Research and Laboratory Services Program provides support to researchers seeking technical and analytical assistance and research fundings to scientists pursuing environmental and industrial waste problems. This chapter presents information on the analytical support functions of the program through brief discussions of selected projects for which assistance was provided. It also discusses the research projects selected for funding and those that haved received continued funding this past year as well as other outreach efforts.

Laboratory Program Activities

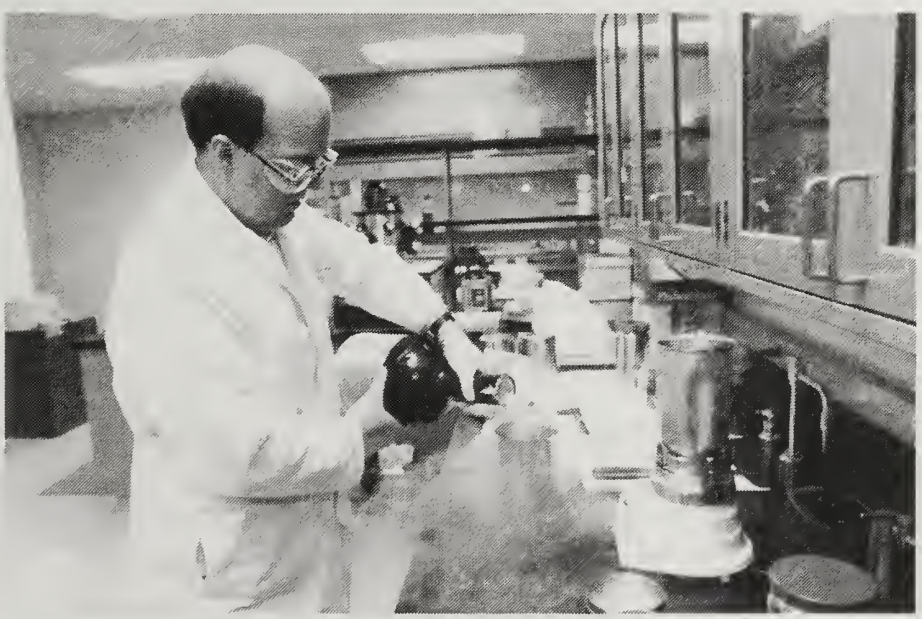
Dredging the Grand Calumet

The Grand Calumet River on the south side of Chicago has received pollutant input from industry and sewage treatment facilities for over 100 years. As a consequence, sediments in the aquatic environment are heavily contaminated with metals and organic chemicals. Dredging for navigational purposes will remove these contaminated sediments, a process that could negatively impact downstream water quality. A better understanding of the existing hydraulics and sediment quality in this river is necessary to assist evaluation of the potential impacts of dredging on water quality in the river. The Illinois State Water and Geological Surveys undertook a study to characterize these impacts on the Grand Calumet River. Sediment cores collected from the river were analyzed by the Geological Survey for metals and other constituents. WMRC analyzed fourteen of these samples for organic contaminants, finding substantial levels of PAH compounds in some of the samples. No measurable levels of polychlorinated biphenyls (PCBs) or pesticides were found in these sediment samples. The laboratory also analyzed several of the samples for mercury, confirming the high levels of this element measured by the Geological Survey chemists. USEPA and others will consider these data in any decision on dredging of the river.

Amphibians as Indicators of Ecosystem Integrity

Recent publicity on abnormally high numbers of frogs in Minnesota that either are missing limbs or contain extra limbs has highlighted the importance of amphibians as indicators of ecosystem integrity. Because amphibians begin life in water and have highly permeable skin, they are prime targets for exposure to any local environmental contaminants and could act as sentinels of hazards to other wildlife and humans. The College of Veterinary Medicine at the University of Illinois, the University of Minnesota-Duluth, the National Wildlife Health Center, and WMRC have formed a partnership to study how amphibian populations are influenced by environmental factors. This study is funded for three years by the USEPA. The Research and Laboratory Services Program at WMRC will provide analysis of surface water and possibly sediment samples collected throughout the upper Midwest as a measure of the chemical quality of these ecosystems. Work has been initiated to refine analytical methods to screen for the wide variety of pesticides and other environmental contaminants that might be found in these samples.

The Program has also accepted amphibian and environmental samples that were collected in Panama by a College of Veterinary Medicine researcher that is a collaborator on the Midwest amphibians project.



David Green pours liquid nitrogen to prepare amphibian samples for analysis.

Amphibian die-off in Panama has reached critical levels and the problems there may have relevance to the Midwestern study. Laboratory staff will be analyzing these tissue, water and sediment samples for pesticides while evaluating and adjusting the effectiveness of their screening methodologies.

DePue Field Characterization Efforts Continue

WMRC remained closely involved with the site characterization efforts at the DePue Wildlife Management Area, near DePue, IL (see Chapter 5 for more on Lake DePue). The site received the dredged material when the lake was dredged in 1983, thereby transferring metal contaminants from the lake sediments to DNR land. DNR is mandated by IEPA to evaluate any risks posed by the site to human health or the environment.

Much of the characterization work at the site is being contracted to various researchers at the Scientific Surveys and additional collaborators at the Illinois Institute of Technology. R&LSP staff have been involved in several of these projects, providing field assistance to the collection of soil cores within the diked area and to the collection and processing of ducks using the site. The lab has also been working on describing, splitting and analyzing the soil cores. Center staff continue to be involved in oversight of the characterization effort, and in soliciting funds through DNR to continue the characterization effort.

WMRC also arranged for the development of an electronic base map that will provide mapping support to all of the various research teams investigating the site. The site was accurately located by Geological Survey personnel using a combination of traditional surveying techniques and global positioning satellite (GPS) equipment. Elevations were carefully surveyed for reference points at the site. All subsequent sampling and well locations have been accurately located and mapped using GPS.

South American Pesticide Connection in Birds

Elizabeth Loebach, a graduate student in the Department of Natural Resources and Environmental Sciences at the University of Illinois, completed a study examining the levels of chlorinated pesticides found in wild bird eggs. In her study, Loebach compared levels of pesticides found in house sparrow eggs to those found in dickcissel eggs. While both bird species summer in Illinois, house sparrows are resident to the area while dickcissels migrate, predominately to one area of South America. Chlorinated pesticides like DDT have been banned for many years in the US but are still in use in areas where the dickcissels winter. Comparison of chlorinated pesticide levels in the eggs of these species offers some insight into the exposures and potential effects of the continued use of these pesticides on migratory bird populations.

Ms. Loebach collected eggs locally and enlisted WMRC's laboratory program to perform the pesticide analysis. WMRC tested and refined methods for extraction of pesticides from the eggs and for cleaning and analyzing the extracts. A total of 100 samples were analyzed over a two-month period, including 82 eggs and 18 quality assurance samples. Ms. Loebach was involved in the work on a daily basis, identifying stages of egg development before eggs were prepared for extraction. The results showed some residual levels of pesticides in the dickcissel eggs that were largely absent in the house sparrow eggs. The implications of these pesticide residuals are still being explored.

Explosive Wastes Biotreatment Studies with CERL Continue

The Army produces dinitrotoluene (DNT) as a contaminant in the manufacture of various propellants. DNT is readily transformed in an anaerobic biological

Laboratory staff use a multitude of techniques to prepare and analyze environmental samples.

reactor to diaminotoluene (DAT), which is theorized to be further broken down under aerobic biological treatment. But the fate of DAT in aerobic sytems is not well understood. Researchers at the US Army Engineers Construction Engineering Research Laboratory (CERL) in Champaign, via a contract with the Center, are looking at the fate of DAT in a laboratory study being conducted at WMRC. Program chemists are supporting these efforts by providing routine analysis for the DAT, and more sophisiticated product elucidation studies applying gas chromatography and mass spectrometry. The project is funded through calendar year 1998.

An open refuse dump located near the Alorton Rookery.

WMRC received a second contract to assist CERL scientists in their efforts to define biological treatment processes for military explosives wastes. In this project, CERL researchers are exploring the microbiological pathways functioning in an anaerobic fluidized-bed granular activated carbon bioreactor. The bioreactor has been shown to be effective in treating some types of military wastes. Researchers are examining the effectiveness of the bioreactor, and the biodegradation products resulting from its application to pink water, a wastewater containing various nitrated aromatics (e.g., TNT) and nitroamine (e.g., RDX) compounds. Such wastewaters result from loading, assembling and packing operations for munitions and from some demilitarization activities. WMRC is providing laboratory space to the researchers and logistical and analytical support for all aspects of the project. WMRC's considerable experience in the analysis of nitroaromatic and nitroamine compounds, acquired through several years of cooperative efforts with CERL, is a primary factor in the continuation of these efforts. This project, currently funded through the end of calendar year 1998, is scheduled to continue for two years.

Alorton Rookery Sampling For Possible Contamination

DNR's Division of Natural Heritage requested the assistance of WMRC in a preliminary assessment of a vacant parcel of land in Alorton, located just south of East St. Louis. The property, formerly in private ownership, reverted to St. Clair County due to the previous owner's default on property taxes. The County has owned the property for a number of years and is now planning to sell it at auction.

In spite of its location in an urban industrial area immediately adjacent to an active railroad yard, the wooded property is home to a heron and egret rookery. Great and snowy egrets, little blue herons, and black-crowned night herons are reported to nest in the area. No structures currently exist on the property, but one end of the parcel contains an open refuse dumping area containing domestic solid waste. The Department was exploring the feasibility of purchasing the property in order to protect the rookery. One aspect of that purchase decision involved identifying any chemical contamination that might exist at the site. Staff from WMRC and the Division of Natural Heritage visited the site in late winter to collect soil and water samples to be screened for metals and selected organic compounds. Results of the analyses were provided to Natural Heritage staff to help the Department assess the potential for liability associated with the purchase of this property. WMRC has not heard whether the plot of land was purchased by IDNR.

Anayltical Methodology Development

Teresa Chow of the Center's Research and Laboratory Services Program received notice that a manuscript submitted to the *Journal of Capillary Electrophoresis* has been accepted for publication in the July/August issue of that journal. The article, "Analysis of the Transformation of Nitroaromatic Compounds in Waste Water by Bacteria Using Micellar Electrokinetic Capillary Chromatography," authored by T. Chow, J. Liu, M. Piwoni and N. Adrian, stems from Ms. Chow's work with Dr. Adrian. Dr. Adrian is a microbiologist at the US Army Construction Engineering Research Laboratory in Champaign and has been working with the Center for several years on biological processes that degrade energetic compounds manufactured for the Army. Several

sites in Illinois, included the Joliet Arsenal, have been contaminated by the manufacturing of TNT and other energetic compounds and the packing and loading of ammunition. Analytical procedures developed by WMRC laboratory staff are allowing Dr. Adrian to explore the feasibility of using biodegradation to treat these contaminants in military waste streams.

Research Program Activities

New sponsored research projects

Three new projects focusing on issues surrounding contaminated lands were begun in FY98. A study entitled, "Investigation of Metal Distributions and Sedimentation Patterns in DePue and Turner Lakes," is being led by Richard Cahill of the Illinois State Geological Survey and William Bogner of the Illinois State Water Survey. This project is examining sedimentation patterns and rates in Lake DePue, and comparing them with those in Turner Lake. The results will contribute to an understanding of the impact the 1982 dredging of the lake had on the redistribution of metals in the lake. Results of this study will also facilitate decisions regarding future plans the village has to dredge the lake and properly dispose of the dredged sediments.

A second project, "Remediation of Metal-Contaminated Sediments with Soluble Phosphate and Phosphate Rock," is underway at the Illinois State Water Survey under the direction of Thomas Holm. This two-year study will evaluate the treatment of metals-contaminated sediments by precipitation of metals as insoluble phosphate salts. The results will contribute to the selection of appropriate remediation strategies for contaminated sediments in the DePue Wildlife Management Area.

A third study, "Analytical Speciation of Zinc and Cadmium in the Sediments of Lake DePue" is being conducted by Jean-FranHois Gaillard at Northwestern University. Multiple techniques are being used in this study to determine speciation of zinc and cadmium in Lake DePue water and sediments. Specific objectives of this one-year project are 1) to establish the speciation of these metals in pore waters, and 2) to characterize the changes in speciation with depth in the sediments. Dr. Gaillard will test the hypothesis that metal mobility is influenced by chemical speciation, which is controlled by microbial activity. The ultimate goal of the project is to better understand natural processes driving heavy metal dynamics in aquatic systems so that effective remediation technologies can be identified.

In the pollution prevention area, two new projects were initiated. A project conducted by Schreiner and Associates, Inc., of DeKalb, Illinois, will work toward development of a system for converting trivalent chromium to hexavalent chromium and removing iron from chrome plating baths. By removing trivalent chromium and iron from the plating bath solution, the solution can be recycled back into the chrome plating process. Benefits of the study will include cost savings for Illinois' chrome plating businesses for raw materials and waste disposal, increased competitiveness among these businesses, and a reduction in the amount of waste entering the environment.

A second project, entitled "Flux Decline Issues in Membrane Filtration of Synthetic Metalworking Fluids," is being conducted by researchers at the University of Illinois' Department of Mechanical and Industrial Engineering. The one-year project by Richard DeVor and Shiv Kapoor will investigate the feasibility of removal of bacteria and other impurities from metal cutting fluids using membrane filtration technology. The results of the work are expected to address the efficacy of membrane filtration technology and occupational health and safety issues associated with worker exposure to the bacteria common in these fluids.

New Research Publications

Strengthening Corporate Commitment to Pollution Prevention in Illinois: Concepts & Case Studies of Total Cost Assessment, Tellus Institute, Boston, August 1997, TR-30.

Innovative Supplier Contracts: A Source of Competitive Advantage, Thomas J. Bierma and Frank L. Waterstraat, Illinois State University, September 1997, TR-31.

Research Projects Completed

Three research projects funded by WMRC were brought to successful conclusions by June 30, 1998. Final reports were received for the following projects:

"Characteristics and Treatment of the Dental Waste Water Stream," by Michael Cailas, James Drummond, Tung-Yi Wu, and Victor Ovsey of the University of Illinois at Chicago;

"Development of a New Filter Technology for Dramatic Reduction of Dry Paint Filter Wastes," by John Spangler and George Mitchell of Caterpillar Inc.; and

"Characterizing Subsurface Contaminant Distribution: Results from a Study of Soil Contamination at Two Agrichemical Facilities," by Donald Keefer and Michael Barnhardt of the Illinois State Geological Survey.

These reports will be published by WMRC and made available to the public through the Center's Information Clearinghouse.

FY99 Solicitation for Proposals

FY99 proposals were received in March in response to WMRC's Fall Request for Proposals. A total of 32 proposals were received in the following subject areas: industrial pollution prevention (10 proposals received); contaminated lands (16), and nonpoint source pollution (6). Proposals were reviewed by WMRC scientific staff and either recommended for external peer review or eliminated from further consideration. The external peer review process was completed by midsummer. Information from these reviews will be used to select projects for funding with FY99 research funds. It is hoped that five new projects can be initiated by December 1, 1998.

Because of its immediate relevance to the Department's activities at DePue, one proposal was identified for funding beginning in July, 1998. The project, "DePue Wildlife Management Area Biological Site Characterization Segment II: Levels and Effects of Selected Metals in Small Mammals," by Jeffrey Levengood and Edward Heske of the Illinois Natural History Survey, will continue the ecological risk assessment begun at the DePue Wildlife Management Area in FY98. The project, expected to be completed in two years, will examine metal uptake by small mammals nesting in and living adjacent to the impoundment and effects, if any, on the viability of their populations. The results of the study will help evaluate the effects of the metals in the impoundment soils on the ecosystem, including the extent to which metals are entering and potentially being transported through the food chain.

Seminar Series

A goal for the Program this past year was to formally solicit seminar presentations from researchers funded through the Center. These "research" seminars became a part of the larger WMRC brown bag seminar series which brought various speakers to the Center, on approximately a monthly basis, for talks on a wide range of topics. Seminars presented by Center-funded researchers are detailed below.

Brian Hackman, a graduate student in Civil Engineering at the University of Illinois, presented a seminar on the research project entitled, "Decatur/Danville Nitrate/Pesticide Removal Project." The project, jointly funded by WMRC, the Electric Power Research Institute, and Illinois Power, was undertaken in December 1996. Work has focused on evaluating membrane filtration and reverse osmosis to remove nitrates and natural organic material in the production of potable water. The project is scheduled for completion in December 1998. Results to date indicate this technology is effective but somewhat costly.

Two methods for removal of impurities from chrome plating solutions were highlighted in seminars entitled, "Removal of Metallic Impurities from Chrome Plating Solution by Electrocoagulation," by Shashi Lalvani of Southern Illinois University, and "Novel Technology for Resource Recovery and Pollution Prevention in the Chrome Plating Industry," by Alex Schreiner of Schreiner and Associates, Inc. John Spangler and George Mitchell of Caterpillar, Inc. presented the results of their work on, "Development of New Filter Technology for Dramatic Reduction of Dry Paint Filter Wastes."

Michael Barnhardt and Donald Keefer of the Illinois State Geological Survey presented the results of their project entitled "Characterizing Subsurface Contaminant Distribution: Results from a Study of Soil Contamination at Two Agrichemical Facilities." The objectives of the project included statistical and spatial evaluation of contamination at two sites, and an evaluation of standard approaches to site characterization.

These four seminars provided an opportunity for researchers, WMRC staff, and other interested participants to exchange ideas in an informal setting on current and future projects of importance to Illinois industry.

Program Outreach Activities

Parkland Chemistry Students Tour the Labs

In what has become an annual occurrence, 50 Parkland College chemistry students participated in a demonstration tour of WMRC's analytical chemistry laboratories. Three tour groups visited five work stations for demonstrations. Station topics were inorganic and organic sample preparation, gas chromatography analysis, liquid chromatography analysis, and metals analysis. The students were required to prepare a written report on what they learned on the tour, with a focal presentation on one of the stations. WMRC has provided educational tours to Parkland chemistry students since the facility opened in 1990.

Lab Manager Dusts Off Chemistry for Springfield Staff

In a related educational outreach effort, WMRC's Research and Laboratory Services Program Manager provided a two-hour presentation to members of IDNR's Natural Resources Review and Coordination staff. The session focused on basic chemistry principles, coupled with information on behavior of chemicals in environmental settings. The discussion was intended to help the attendees deal with questions encountered in their daily activities.

4: Information Services

Introduction

The need for concise and accurate information to help companies manage their wastes more effectively continues to increase. Many source reduction techniques and technologies not only result in reduced wastes, but also lead to greater productivity and improved product quality. Technical assistance providers and their clients want easily accessible, thoroughly evaluated, and economically feasible waste management options that increase materials productivity, achieve compliance objectives, reduce wastes, and increase profits. The pollution prevention information WMRC provide must present viable options for reducing wastes, operating more efficiently, and avoiding the mistakes of others. WMRC staff work to meet these provider/client needs by developing new information materials, compiling and verifying existing materials to ensure quality, and making all of these information resources readily available through various delivery mechanism.

The Center's library/clearinghouse collections are well known resources to researchers, assistance providers, educators and others looking for waste management options. WMRC have worked to complement and expand these resources by learning what is available elsewhere and developing partnerships with other information developers and suppliers. Early regional efforts are now national interactions/partnerships with joint projects and shared resources.

The information available to Center staff and the various communities we serve has greatly increased with the growth of Internet, which has made distribution, and exchange of information almost effortless. The Internet has proven to be a valuable resource for locating as well as distributing information and an ideal marketing tool for promoting the Center's resources and services. Considerable effort was been put forth during FY98 to keep WMRC's web site interesting, attractive, and current. Web site development and maintenance are parts of several of WMRC's federally funded projects. Part of the site development activities includes identifying appropriate sources for links to and from WMRC. During FY98, several members of WMRC's staff received training to accommodate this growing need for web site development.

While source reduction./pollution prevention is a major topical area for WMRC's library/clearinghouse, these collections include many more topics relevant to the citizens of Illinois. Information is also collected on general environmental issues; current federal, state, and local regulations; contaminated site remediation technologies and case studies; brownfields; sustainable development; curricula for all education levels; recycling; industrial processes; environmental management; etc. Basically, information staff works with other Center staff and others who frequently request information to select the items that are added to the library/clearinghouse collections. Senior management staff at DNR, for example, was provided with educational materials developed by WMRC and asked to evaluate them. Additionally, Center staff participates in DNR committees and activities, such as Conservation Congress, to learn more about what is available through the Department and what information gaps exist that the Center might fill.

WMRC's data management group maintains several databases (see Section 2). These data are used for specialized searches on specific areas in Illinois and frequently result in customized maps that depict various natural features and/or industrial usage of the site. DNR provided funding in FY98 to apply these databases to natural areas already owned by the state and some that were being considered for purchase. The results were provided as written reports with maps and on CD-ROM. Other special request searches were handled to address property transfer questions most frequently from the private sector that paid for this service. These databases can also provide current pollution records for industries that are potential clients of WMRC's pollution prevention engineers.

Federal funding has been supporting several information-related projects conducted by WMRC staff. Two are now completed, but two other efforts will continue for the foreseeable future. All share the same goal of providing the assistance community and their clients relevant, current, and accurate answers to their waste management or process related questions. Several of these on-going projects have been described in detail in previous reports. This chapter generally includes an update of FY 98 activities.

Pollution Prevention Assistance and Information Database (P2AID)

Funding from the National Institute of Standards and Technology (NIST), part of the U.S. Department of Commerce, was awarded to WMRC in 1995 to develop a custom-designed information resource for field engineers

helping manufacturers to modernize. NIST supports a network of Manufacturing Extension Programs (MEPs) who work with companies to modernize their processes and increase their competitiveness. WMRC was funded to provide environmental, and more specifically pollution prevention, information for MEP engineers to use in their efforts with industries. Three partners assisted WMRC with this project: the Northeast Waste Management Officials' Association (NEWMOA), the Solid and Hazardous Waste Education Center (SHWEC) of the University of Wisconsin, and the North Carolina Office of Waste Reduction (NCOWR).

The information was originally intended to be available as an INMAGIC database that could be used on a personal computer by field staff on location. As the project evolved so did the database design. The final product is a web-based system that uses Lotus Notes Domino. The project team focused on three sectors for the developing database: printing, wood products, and industrial machinery. The types of information collected for each of the sectors included: case studies of successes, an annotated bibliography of articles and reports, relevant environmental regulations, descriptions of environmental technologies, a directory of pollution prevention vendors and service providers, self-assessments and checklists, links to related information resources and tools, and an on-line question and answer service.

This web-based, fully searchable database was piloted with several MEPs in early 1998 and small modifications were made based on their feedback. Funding ending before information for all of the sectors was added, but printing and wood products has considerable resources in their portions of the tool and while industrial machinery is incomplete it does contain a considerable amount of information on metal fabrication and coatings. The project team will be updating information as time permits. The site can be accessed by entering the URL: /chemical.hazard.uiuc.edu.

Developing a Pilot Inter-Regional Information System

In 1995, USEPA funded a project with NEWMOA to explore the options for information sharing among regional groups. WMRC and SHWEC were funded as subcontractors on this grant to represent the Great Lakes and work with NEWMOA to develop a model for resource sharing and inter-regional interactions. The project examined inter-regional cooperation through the development of new sector specific materials for assistance providers. The groups selected four topical areas and worked together to develop manuals that selected the best of the existing information on the topic and customized it for the assistance provider, added descriptions of the best pollution prevention technologies for the topic, and provided a list of additional resources. NEWMOA produced manuals on metal finishing and metal coatings and WMRC produced manuals on printing and the primary metals industry.

Information sharing was also accomplished through a list server where questions could be posted and addressed by the list server members almost immediately. Two list servers were set up by SHWEC and after the first year taken over and maintained by WMRC.

These list servers are national in scope. They are P2Tech, which is dedicated to discussions of technical solutions to waste management problems, and P2Reg, which facilitates discussion of regulatory issues. The project showed that the assistance community likes the list server format as a mechanism for information exchange. P2Tech has over 450 subscribers and moderate daily traffic of about 20 queries/responses. The original funding for this list server ended with this project; however, its popularity and ease of operation prompted new funding from USEPA (as part of the P2Rx project discussed below) to continue its use through September 2000. In contrast P2Reg had competition from several other list servers and discussion groups and had few subscribers and little traffic. This list server is no longer functional but the questions it was designed to answer and very adequately addressed on the National Pollution Prevention Roundtable list server NPPR.

The final portion of the project was to suggest a model for a national network that would facilitate information exchange while avoiding duplication of effort and providing all of the funding sources greater benefits for the money they were spending. Three models were proposed, but the one adopted by USEPA was that of a distributed information network with regional centers that work together. A coordinating group guides the network and provides the opportunity for scheduled formal interactions of the participants. Funding for this effort is being provided by USEPA. This is the P2Rx information network in which WMRC participates as the information center for the Great Lakes area.

The Great Lakes Regional Pollution Prevention Roundtable (GLRPPR)

Since October 1996, WMRC has been host for the GLRPPR. In this role, WMRC is funded to provide an Executive Director; coordinate two annual meetings for information exchange; work with the steering committee to identify, develop, and maintain member services and information resources; and represent GLRPPR at various meetings. Information exchange occurs not only at the meetings, but also through newsletters, conference calls, list servers, a web site and an information specialist to respond to questions.

WMRC staff member Lisa Merrifield is the Executive Director of the Great Lakes Regional Pollution Prevention Roundtable.

The annual meetings occur in February/March in Chicago at the Region 5 offices and in one of the Great Lakes states in August. The August 1997 meeting took place in Minneapolis and had as a theme sustainable development. This meeting adopted a conference format in which the presenters provided fairly detailed descriptions of their successful projects and took questions. The Chicago meeting in March 1998 was a workgroup meeting with informal brainstorming sessions to learn about the activities that had taken place in the region and to select opportunities for the participants to interact in the future.

During FY 98, WMRC received funding to make the Executive Director position full time, and Lisa Merrifield has assumed this directorship. As part of the project deliverables, the Director develops and maintains the GLRPPR web site, coordinates and monitors several list servers for between meeting discussions of the workgroups, works with the steering committee to improve existing services and provide new ones, coordinates the meetings, and oversees a journalism student who produces the quarterly newsletter (LINK). Additional information about the GLRPPR is available through its home page (www.hazard.uiuc.edu/wmrc/greatl).

The Great Lakes Pollution Prevention Information Center

Additional funding has been provided to WMRC to maintain two large national databases. One, TechInfo, consisted of a bibliographic database of technical information available from 11 different information centers in the US and Canada. The second database, VendInfo, provided information on vendors of pollution prevention equipment and service providers. These databases were considerably smaller 4 years ago when the collection process began. Today, they are extremely large and contain outdated data. Upkeep is increasingly difficult due to lack of cooperation by the original contributors. Internet growth and the rapidly increasing amount of information that can be found there has also diminished the value of these databases.

Over the last year, WMRC has updated these databases and sent the updates to be posted on the Enviroene site. However, evaluation of the databases by users verified our hypothesis that they were no longer very useful. Combining this with the results of the pilot study about an information network has caused us to change our focus on information collection and distribution. The current plan is to look for regional electronic resources available through the Internet. These will be briefly described and linked to the GLRPPR site. A small collection of useful documents will be maintained at WMRC as a regional clearinghouse. Finally, an information specialist will be available to undertake searches for assistance providers in the region and participating in the national information network, P2Rx.

P2Rx has been mentioned several times in this chapter. It is a direct outgrowth of the pilot inter-regional project described earlier. USEPA has funded 9 regional information centers to work together in a coordinated effort to expand available national information resources. WMRC was awarded the contract to serve as the information center for the Great Lakes. The evaluation of the existing national databases was part of the first year's effort on this project. During the second year of the project WMRC became a center of excellence for the printing industry. This means that we have agreed to use our resources to respond to questions related to printing and the printing industry from any and all of the regional centers. Included in the P2Rx project is maintenance of the P2Tech list server. This national effort is just beginning but has the potential of becoming the primary information source for USEPA and several other federal agencies.

Plans for FY99

The GLRPPR and P2Rx involvement will continue for at least the next two years. These projects have expanded

WMRC's resource base, provided valuable contacts, and resulted in added recognition for WMRC as an integral component of the pollution prevention community. During FY99 we plan to increase the resources we develop, the contacts we make, and the quality of the responses that we provide. Additional funding to keep these successful activities and expand them will be explored.

Having begun to assess and improve our electronic resources, we are now adding to that effort by doing the same with the printed resources available in our library and clearinghouse. During FY98 users will be asked to let us know how well we have handled their problems. This information will be used to modify the existing collection and set a focus for expanding what we offer.

5: Special Issues

Introduction

WMRC staff have become involved in a number of issues and projects which have agency-wide (DNR) implications. In this chapter we highlight a few of these issues and the Center's role in helping address them. An important task that has emerged for the Center is providing a coordination and management function for some complex environmental issues that require the expertise of a variety of scientists and groups within DNR and the Scientific Surveys.

Investigation of New Dredging Techniques for Restoring Shallow Water Habitat

WMRC is coordinating Department of Natural Resource's efforts to investigate the feasibility of using emerging high solids dredging techniques to remove sediment from shallow water habitats such as river backwaters and reservoirs. Initial efforts are focused on the Illinois River where this ubiquitous water pollutant has filled over 70 percent of the volume of 60,000 acres of Peoria Lake portion of backwaters. These areas now average less than 18 inches or less in depth and are in the process of being converted to willow covered mudflats. The sedimentation is a major factor in the habitat degradation associated with the marked decline in wildlife populations over the past 100 years. Removal of the sediment will be necessary as well as prevention of sediment reinfiltration.

IDNR is working with private industry to develop and test two types of new technology. One is basically a large wheel excavator that will scoop sediment up from a waterbody without mixing it with water. The sediment will be removed at a rate of 1600 cubic yards per hour and deposited as mud rather than a slurry. This technique promises to allow dredging with minimal release of any contaminants. The other concept is a high solids pump which is expected to remove sediment and pump it with a solids content of over 50% by weight. By varying the size of the pump it should be possible to dredge large open areas as well as around docks and in selected portions of wetlands. This technology could be used to place material in trucks or barges.

With suitable dredge technology it will be possible to partly restore the habitat diversity which existed at the turn of the century. This includes building islands to break up wind fetch and provide nesting and resting habitat. Carefully shaped piles of dredged material could provide enough elevation for floodplain hardwoods to repopulate areas where they have been excluded by higher water levels. Removing up to six feet of sediment in selected areas will provide much needed deep water for fish outside the main channel. The concept is to provide a wide variation in the depth of water and elevation of land in restored areas that will allow fish and wildlife populations to rebound.

As part of this effort sediment samples from the Peoria pool are being characterized. They are being tested for a variety of possible contaminants, potential agronomic or material value and physical properties.

Uses must be found for hundreds of millions of yards of sediment if a restoration project is to succeed. Potential uses beyond habitat restoration include using the material as manufactured landscaping soil, as a soil amendment on farmland, as part of strip mine reclamation, and as fill for recreation and construction projects. It may also be suitable for mixing with flyash to create flowable fill.

The effort involves numerous IDNR divisions including ISGS, INHS, ISWS, and Mines and Minerals. The Illinois Department of Transportation, Corps of Engineers, Heartland Water Resources Council and numerous other organizations are also involved.

The importance of this effort lies in the fact that the backwaters will be permanently lost beneath a tangle of willow trees within a decade or two if a means of removing sediment deposits and controlling future erosion is not found. Dredging will remove part of the sediment which has accumulated since 1900 when Chicago began diverting Lake Michigan water down the Illinois. It will deepen the backwaters enough to buy the time necessary for scientists and wildlife managers to learn how best to manage the watershed to assure that fish and wildlife resources remain for future generations.

Investigation of Contamination at DNR's Lake DePue Wildlife Management Area

Since January 1997, WMRC has been working on environmental investigtaions at the DePue Wildlife Management Area (DWMA), a DNR managed and State owned parcel of land. These investigations are necessary to determine the level and extent of heavy metal contaminants that have been found to exist in Lake DePue sediment. Nearly 450,000 cubic yards of contaminated lake sediment was placed in diked lagoons on DNR

property as part of a Lake DePue dredging operation that occurred in 1983. The diked lagoons are planted with crops each spring to attract waterfowl and are then flooded in the fall for waterfowl hunting.

WMRC has funded seven studies to help characterize contamination at the diked lagoons. Three of the studies began in the fall of 1997, with the remaining four beginning in the summer and fall of 1998. Various studies involve the Illinois Natural History Survey, Illinois State Geological Survey, Illinois State Water Survey and the Illinois Institute of Technology. Data generated from these studies will enable WMRC staff to determine the levels of contaminants at DWMA and to assess any risks, either human health or ecological, that may be associated with these contaminants.

Due to the nature of some of the contaminants that may be present in the diked lagoons, DNR staff are required by the Occupational Safety and Health Adminstration (OSHA) regulations to be trained in hazardous materials safety procedures and to be enrolled in a medical monitoring program. DNR staff that are involved in the investigations at this site continue to be trained in the appropriate safety related areas, updating required health and safety requirements on an annual basis.

Currently, investigations at the site are projected to conclude within the next three years. WMRC will begin screening remedial alternatives once data have been generated for the site. Alternatives range from no action to removing all of the contaminated sediments and relocating them to an IEPA permitted loation. WMRC and DNR representatives will select a proposed remedy for the site which will be followed by a formal public comment period. Once public comments have been addressed, a final remedy for the site will be formalized and implemented.

WMRC supported research to investigate the uptake of metals in waterfowl using the DePue Wildlife Management Area.

Natural Resource Damage Assessment Program Description

Contamination of land and water by pollutants may result in the loss of natural resources such as wild animals, species diversity, habitat, and the services natural resources provide to wildlife, residents and visitors to the State of Illinois. Enhancement and/or restoration of natural resources damaged by pollution represents a significant and expanding effort of WMRC.

Federal regulations including the Clean Water Act, Comprehensive Environmental Response Compensation and Liability Act (Superfund), and the Oil Pollution Act provide natural resource trustees the authority and procedures to assess damages to natural resources and to collect compensation for those natural resources damaged by oil or hazardous substances. Illinois natural resources trustees, the DNR and IEPA, have been designated by Gov. Edgar to be Trustees of Illinois' natural resources.

WMRC continue to lead DNR's work toward developing a partnership with IEPA, developing a natural resource damage assessment (NRDA) program that will focus on protecting, enhancing, replacing, or restoring Illinois natural resources. The approach of this program will be to avoid impacts to the fullest extent possible, minimize unavoidable impacts, and where appropriate, mitigate those impacts through measures such as restoring or creating habitat.

WMRC continues to coordinate the organization of a joint DNR/IEPA work group which has developed a framework for an Illinois NRDA program. The work group has developed a joing Memorandum of Agreement (MOA) for further implementing the Illinois NRDA program. The MOA has been signed by IDNR and is awaiting signature by IEPA.

Partnering with other federal agencies such as the US Fish and Wildlife Service (USFWS) continues to be a major goal in developing the Illinois NRDA program. The USFWS continues to assist Illinois trustees in maintaining the state's trust resources within the combined framework of state and federal regulations. Illinois trustees will seek to develop and sign a joint MOA with USFWS in early 1999.

Other DNR Contaminated Sites

Hazardous materials that are contaminating land owned by the State of Illinois and managed by DNR are an important environmental concern. WMRC hired a Remediation Manager in January 1997 to address contaminant iusses not only at the DWMA but also at other DNR sites contaminated with hazardous waste.

The magnitude of contamination problems at other DNR-owned lands has yet to be determined. However, it is known that some DNR properties are contaminated with various kinds of wastes, or contain old landfills, dumps, leaking underground storage tanks, or leaking pipelines. Many of these sites need to have the extent of contamination characterized and some will require more detailed investigations to determine how best to deal with contaminants of concern.

WMRC's efforts in identifying contaminated DNR properties have increased in the last several years.

WMRC continues to participate in document reviews, planning and sampling events at a number of DNR sites. Collaborative efforts with several offices within DNR have been developed in an effort to deal efficiently and effectively with various contaminant issues. Projects such as Illinois Beach asbestos contamination, Ottawa Radium Dial, and the Alorton heron rookery have involved WMRC staff this past year. WMRC will continue to assist DNR in the coming year with its efforts to identify and eliminate liabilities associated with its contaminated properties.

Turbidity and Microorganism Removal from Drinking Water

Microfiltration technology is rapidly gaining acceptance as a reliable means of reducing turbidity and microorganism levels in surface waters and is considered especially promising for small water utilities in complying with the increasingly stringent performance standards of the Safe Drinking Water Act.. The primary reasons for the rapid acceptance of this technology is its perceived ease of operation and insensitivity to wide fluctuations in source water quality. The filters that have been tested to date have been polymeric. Ceramic microfilters, a more recent entry in the marketplace, offer unique advantages such as oxidation resistance and high pressure capability that can significantly extend the operation range of the polymeric microfilters. Very little information is available on the performance and economic viability of ceramic filters under field conditions.

Now, engineers from WMRC are conducting studies to verify the effectiveness of advanced ceramic microfilters to remove microorganisms and turbidity from surface waters under field conditions. The studies are being conducted in conjunction with City of Mattoon water department and specifically looks at issues related to equipment performance and economic viability. An automated pilot plant with advanced data collection capability and on-board instrumentation is being utilized. Results from the extensive testing planned are expected to be available in 1999.

Putting the Squeeze on Metalworking Fluids

It is estimated that approximately 1-2 billion gallons of effluent are generated from the use of metalworking fluids in the machining process. While reasons for disposal of metalworking fluids vary, microbiological deterioration is a significant one. One common means of microbial growth is the use of biocides. The practice is not always effective and creates additional health and safety risks. Microbial contamination, by itself, has also been determined to pose health and safety risks. Additionally, some types of metalworking fluids such as synthetic and semi-synthetics are difficult and expensive to treat.

A comprehensive research program in partnership with the Machine Tool Agile Manufacturing Research Institute at the University of Illinois has therefore been initiated at the WMRC to identify and evaluate technologies for effectively controlling microbial growth and simultaneously reduce the volumes of effluent disposed. One important goal is to also reduce the use of biocides, where possible. Bench scale work to date has shown that microfiltration technology has the potential to reduce microbial levels significantly while preserving the integrity of the metalworking fluid. Additional pilot trials have also been scheduled at a major machine tool manufacturer in fall of 1998.

Pilot Environmental Site Assessments of DNR Facilities in East Central Illinois

Beginning in June 1998 personnel from WMRC began a series of environmental assessments at DNR sites in the east central region (Region 3). These assessments were prompted by knowledge that there are obsolete chemicals in need of disposal at several DNR sites and by past experiences at other DNR sites that have environmental contamination and which will require expensive clean-ups. Over the summer eleven of thirteen sites in this region were visited by the assessment team to assess any potential environmental issues that needed to be addressed and to get a general idea of what sorts of environmental issues DNR faces at its facilities. The assessments were carried out with assistance of site personnel, who guided the assessment team through the sites. The following were some of the main problem discovered that are common to most sites:

Chemicals Storage and Use

Most facilities have some materials which they no longer use and which need disposal. In most cases these are small amounts that are not a serious problem. There are materials not used at some sites that could be used at others.

Unclosed Abandoned Wells

At most DNR sites, personnel have made efforts to locate and fill any wells that are easily accessible to the public. The number of remaining unclosed wells varies widely, however, depending on the location. At the Lake Shelbyville sites, which are leased from the Army Corps of Engineers, the Corps has cataloged and closed nearly all of them. There are other sites though, that have a several unclosed wells. This represents an environmental hazard and also a safety hazard to users of DNR facilities.

Risk Management Plans for Propane Usage

Nearly all DNR sites use propane for heating and energy needs. The USEPA, under authority given to it in the Clean Air Act Amendments of 1990, requires users of extremely hazardous chemicals, of which propane is considered to be one, to prepare risk management plans (RMP) for preventing and dealing with potential releases. In the case of propane there is a significant explosion risk in case of a release. Sites which keep more than 10,000 pounds (about 2,500 gallons) of propane need to prepare a plan and submit it to USEPA by June 21,1999.

Design Criteria for Waste Water Treatment Systems

Most sites visited have some sort of waste water treatment system, in some cases several. In many cases site supervisors have had to modify the systems (most sites have a certified operator) in order for them to meet treatment standards.

Recycling

Recycling is practiced somewhat inconsistently at DNR sites. Most sites have recycling sheds, but not all of them are put out at accessible locations where the public can get at them. The main two reasons why this is not done are first, the sheds are an upkeep and maintenance problem, and second, in some locations there is no market for the collected materials. These are a problem mainly at smaller or more remote locations.

Over the next year WMRC staff will be assisting site managers in Region 3 to address these and other concerns. A recommendation has also been made to DNR to expand this effort state-wide.

Appendix A: WMRC History

In September 1984, the General Assembly passed the Hazardous Waste Technology Exchange Service Act (20 ILCS 1130/1) mandating the Department of Energy and Natural Resources (DENR) to establish a Hazardous Waste Technology Exchange Service Program, later renamed as the Hazardous Waste Research and Information Center (HWRIC). The Center was to be temporarily administered under the guidance of the State Water Survey until HWRIC could operate as an independent division of DENR. Funding was appropriated through the General Revenue Fund and the Hazardous Waste Research Fund.

In 1989, the Program was officially renamed as the Hazardous Waste Research and Information Center (20 ILCS 1130/4). It was then separated from the State Water Survey and became a separate division of DENR. Following this legislation, the Center was designated by the University of Illinois as a separate "allied organization" and was administratively separated from the State Water Survey.

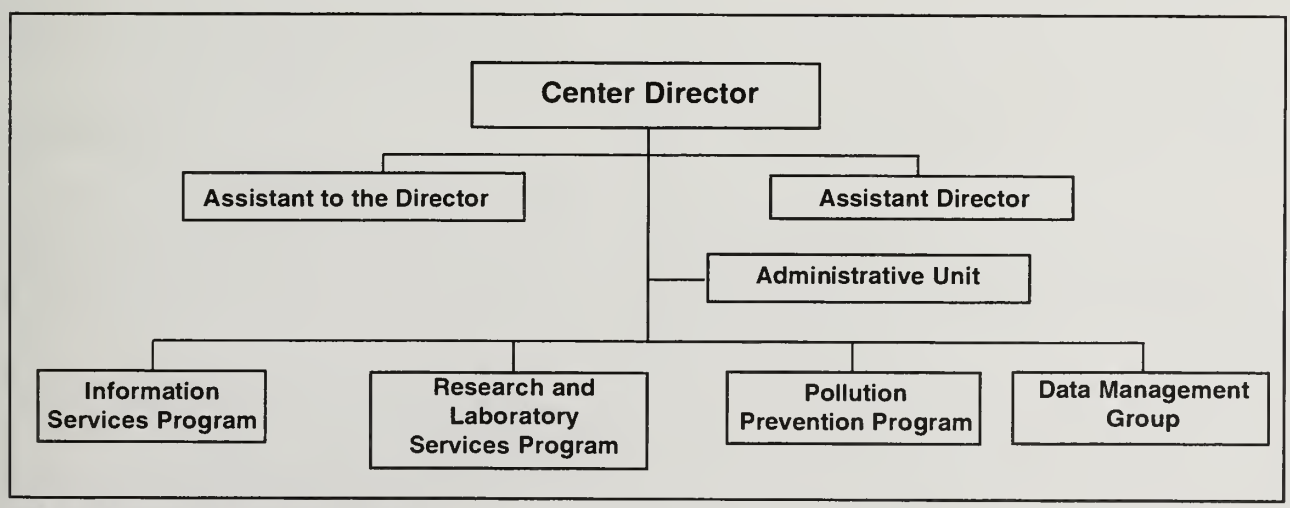
In August 1996, the Board of Natural Resources and Conservation (BNRC) voted to change the Center's name to Waste Management and Research Center (PA90-0490). The new name better reflects the broad range of service provided by the Center, which deals with all waste-related issues and releases to environmental media.

The Center's mission is to combine research and education; oversee information collection, analysis and dissemination; and direct technical assistance to industry, agribusiness and communities in a multidisciplinary approach to better manage the state's wastes and solve problems associated with it. The Center's Pollution Prevention Program, initiated in 1989, builds on the research, information and technical assistance aspects of other Center programs to help industry and others reduce or eliminate waste at the source. The Illinois Pollution Prevention Act (TPPA) of 1989 established a Toxic Pollution Prevention Assistance Program within HWRIC to (1) provide industrial and technical assistance; (2) encourage pollution prevention; (3) promote better waste management through research; and (4) provide information dissemination and technology transfer.

Prior to 1997, the Center consisted of four programs: Research, Information Services, Laboratory Services and Pollution Prevention, along with an Administrative Unit and Data Management Group. An internal reorganization took effect in January 1997, which reduced the number of programs to three by combining the Research and Laboratory Services programs into one.

The Center was initially housed in temporary offices on the corner of 6th Street and Springfield Aveune in Champaign. The Center's first director, Dr. David L. Thomas, was hired in May 1985. Center staff relocated in October 1985 to temporary offices in Savoy.

In Summer 1985, Envirodyne Engineers, Holabird and Root, and Altay and Associates were selected to begin designing the state-of-the-art Hazardous Materials Laboratory (HML). In July 1988, the ground breaking ceremony was held starting the construction of the facility. The building was completed in Spring 1990 and



WMRC FY98 Organizational Chart

the staff moved into the HML in April. A building dedication was held on April 20, 1990 in conjunction with Earth Day.

In November 1994, WMRC opened an office in Chicago, co-located with the Chicago Manufacturing Center at Homan Square. The Chicago office relocated to Oak Brook in April 1998. The Chicago staff are under the Center's Pollution Prevention Program and assist with the Center's technical assistance activities.

In February 1997, WMRC established a Springfield office when a Remediation Manager was hired. This office deals with problems associated with state-owned contaminated lands and Natural Resources Damage Assessment (NRDA) issues.

Appendix B: Staff Publications and Presentations

Publications

Andes, R.P., K. Rajagopalan, T. Lindsey, J. Pickowitz and C.L. Barkan. "Extending the Life of Railroad Shop Cleaners with Ultrafiltration," *Association of American Railroads: Risk Management Division.* 1997. TD97-043.

Chow, Teresa. "Analysis of the transformation of nitroaromatic compounds in wastewater by bacteria using micellar electrokinetic capillary chromatography." *Journal of Capillary Electrophoresis* July/August 1997, 4(4):189-194.

Hayes, C., T. Lindsey and R. Lanyon. "Partnerships Between Technical Assistance Providers and POTW's to Promote Industrial Pollution Prevention in Illinois." Conference Proceedings of the Water Environment Federation's 70th Annual Conference and Exposition. Chicago, October 1998.

Lindsey, Timothy C. "Diffusion of P2 Innovations." *Pollution Prevention Review* Winter 1998 8(1):1-14.

Nelson, W.M. "Life Cycle Assessment Comes to Life" 1998, *Precision Cleaning*, June, 12-15.

Nelson, W.M. "Art in Science: Utility of Solvents in Green Chemistry" in *Green Chemistry, Frontiers in Benign Chemical Synthesis and Processing*, August 1998, published by Oxford University Press.

Nelson, W.M.; Puri,I.K. "Oxidation of CH_3CHO by O_3 & H_2O_2 Mixtures in Supercritical CO_2 In a Perfectly Stirred Reactor," *Ind. Eng. Chem. Res.*, 36 (9), 3446 -3452, 1997.

Sweet, C.W., A. Weiss and S.J. Vermette. "Atmospheric deposition of trace metals at three sites near the great lakes." *Water, Air and Soil Pollution* **103**: 423-439 (1998).

Presentations

Brown, J.C. "Industrial Issues and Treatment Technology: Metal Products and Machinery" Presented at WEFTEC'97, the 70th Annual Conference and Exposition of the Water Environment Federation, October 1997, Chicago, IL.

Lindsey, T.C. and S.J. Skerlos. "Achieving Environmental Protection through Environmentally Conscious Manufacturing," Presented at the Sierra Club's Quarterly Meeting, February 1998, Urbana, IL.

Lindsey, T.C. "Methods for Promoting the Diffusion of Pollution Prevention Technologies" Presented at the National Pollution Prevention Roundtable, April 1998, Cincinnati, OH.

Lindsey, T.C. "Improving Pollution Prevention Adoption at Railroad Facilities" Presented at the Association of American Railroads Pollution Prevention and Environmental Management Conference, May 1998, Austin, TX.

Lindsey, T.C. "Applying Innovation Diffusion Techniques to Manufacturing Extension Project Development" Presented at the Illinois Manufacturing Extension Center Quarterly Meeting, June 1998, Champaign, IL.

Nelson, W.M. "Green Solvents" Green Chemistry and Engineering Conference, July 1998, Washington, D.C.

Nelson, W.M. "Life Cycle Assessment and Industrial Cleaning" CleanTech 98, April, 1998, Chicago, IL.

Nelson, W.M. "Design, Appearance and Functionality of the Aqueous Cleaning Database" National Pollution Prevention Roundtable national Meeting in Cincinnati, Ohio, April 30, 1998.

Nelson, W.M. Speaker: "Metal Cleaning for Metal Finishing" Illinois EPA sponsored talk to Metal Finishers in Addison, Illinois, February 19, 1998.

Nelson, W.M. Speaker: "Extraction and in-situ Oxidation of Organic Wastes using supercritical CO2" Fifth Chemical Congress of North America symposium on Industrial Cleaning Without Chloro-fluorocarbons, November 11-15, 1997, Cancun, Quintanza Roo, Mexico.

Nelson,W.M. Poster topic: "Cleaning Technologies Partnership: WMRC, NORBIC, Graymills Corp., and Argonne National Labs," 1997 Gordon Conference on Environmentally Benign Organic Synthesis, July 17,1997 through July 21, 1997, Oxford University, UK.

Nelson,W.M. and Puri,I.K. Poster topic: "Use of Supercritical Fluid Oxidations in Pollution Prevention," 1997 Gordon Conference on Environmentally Benign Organic Synthesis, July 17,1997 through July 21, 1997, Oxford University, UK.

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